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## Technology practices: Confirmatory factor analysis and exploration of teachers' technology integration in subject areas

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### ABSTRACT

It is thought that gains in student learning from the use of digital technologies are more likely to be related to teachers' practice than the technology itself. In secondary schooling, a key aspect of this is concerned with understanding how digital technologies are used to support teaching and learning in specific subject areas. Subject areas have their own conventions and expectations for learning that will influence teachers' technology use and technology-supported student tasks. The aim of this paper is to present confirmatory factor analysis of a scale considering common technology-related tasks in three subject areas. Data included in the current analysis are teacher questionnaires collected in 2010 ( $N = 3624$ ), as part of a large-scale one-to-one laptop initiative in Australia. Results from the 2010 data confirm a five-factor structure revealing significant differences in teachers' professional and instructional uses of digital technologies among three core subject areas: English, Mathematics and Science. Trends are confirmed through a second teacher data set collected in 2011 for Wave 2 of the same one-on-one laptop initiative. Implications of these findings in relation to understanding and supporting effective technology integration and areas of future research are discussed.

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## 1. Introduction

The types of technology-related tasks teachers perform in their professional work, and those they ask students to perform as part of learning, are not random. They are underpinned by deep beliefs about teaching and learning, individual and group values, and driven by educational goals and aims. There is a large body of research examining teachers' technology use in relation to beliefs about technology, teaching and pedagogy (Hennessy, Ruthven, & Brindley, 2005; Inan & Lowther, 2010a, 2010b; Miranda & Russell, 2012; Prestridge, 2012); however, technology integration is not only about teachers' individual beliefs or pedagogy. It has been suggested that where teachers struggle to adopt, or seem to resist, technology integration, a contributing factor may be a 'culture clash' between that subject area and use of digital technology (Goodson, Mangan, & Cultures, 1995; Howard & Maton, 2011; Selwyn, 1999). There is a specific need for empirical work examining technologically-related practices in subject areas and the role of digital technologies (Scheuermann, Pedró, & Pedr, 2010; Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011).

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This paper addresses the question of differences in teachers' technology use among three subject areas. A major premise of this investigation is that not all digital technologies and related teaching practices are equally useful in all subject areas. The use of digital technologies and related tasks results in unique affordances and effects in the learning environment, such as differences between use of data simulations (e.g. exploring complex systems; e.g. Rutten, van Joolingen, & van der Veen, 2012) and use of an online discussion (e.g. engaging in a critical discussion with peers; Hovardas, Tsivitanidou, & Zacharia, 2014). Each of these may be used in potentially different ways to engage in learning. Whether these differences are real or socially constructed (see Selwyn, 2010), they are a basis for selecting and integrating technology. Teachers are likely to use strategies and tools they *feel* support teaching aims and are relevant to student learning (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012). However, research has also identified that subject areas have an effect on technology integration (Goodson et al., 1995; Hennessy et al., 2005; Howard, Chan, & Caputi, 2015; Selwyn, 1999). This suggests that, notwithstanding the effects of other predictor variables on teachers' technology use, integration would also be about the specificities of subject areas, content being taught and affordances of digital technologies to support learning in these contexts.

This paper presents a scale measure (Teacher Technology Practices; TTP) addressing a range of common technology-related tasks, including those teachers perform and those they ask students to perform. This measure is then applied to empirically examine some differences in digital technology use among subject areas. To do this, we first present a brief background of research into technology integration in schools and teachers' technology practices. The TTP scale measure is then presented and discussed. Testing of the measure was conducted using data collected as part of a four-year study of Australian secondary teachers within a state-level one-to-one laptop program (2010–2013). Using teacher data collected in 2010 ( $N = 3624$ ), a five-factor construct was identified, validated and then used to examine some simple differences in technology practices among three core subject areas: Mathematics, English and Science. Results were compared with a second set of data collected in 2011. It is beyond the scope of the present paper to examine the full 2010–2013 data sets for the longitudinal trends of the identified factor structure. However, future analysis will continue validating the factor structure and examining trends over 2012 and 2013.

Much of the research examining differences in subject areas and digital technology use has been qualitative (Hennessy et al., 2005; Ottenbreit-Leftwich, 2012; Webb & Cox, 2004). The current research builds on existing knowledge of teachers' beliefs, pedagogies and learning contexts to empirically explore some of the different ways technology integration occurs in core subject areas. Understanding 'effective use of technology is a prerequisite to any realization of positive educational outcomes resulting from [technology] resources' (Bebell & O'Dwyer, 2010, p. 7). The research extends current knowledge by providing a framework through which relations among current technologies, teaching strategies and learning can be examined. Finally, we will address how the TTP measure may be used in future research, specifically to explore trends in the 2012 and 2013 data sets, and how the TTP may be improved.

## 2. Background

Over the past few decades, there has been a dramatic increase in access to information and communication technologies (ICTs) available in school classrooms, but comparable integration of these tools across teaching and learning is still very inconsistent (Ertmer & Ottenbreit-Leftwich, 2013; Perrotta, 2013). Some of this inconsistency and variation arises from complex questions about effective integration and their effects on learning.

### 2.1. Digital technologies and subject areas

In secondary schooling, a particular area of concern for many teachers continues to be how digital technologies are most effectively integrated in their subject area (Hennessy et al., 2005; Perrotta, 2013; Warschauer, Cotten, & Ames, 2011). Limited understanding of digital technologies and incomplete empirical evidence has resulted in difficulty applying effective instructional methods in different learning contexts (Davies & West, 2014).

That said, research has provided a strong basis for identifying that integration is happening (see Inan & Lowther, 2010a, 2010b; Warschauer et al., 2011) and that there is a critical relationship between teachers' beliefs and technology integration (Ertmer & Ottenbreit-Leftwich, 2010). However, there have been relatively few studies investigating technology integration in specific subject areas. A key study in this area is Goodson et al.'s (1995) investigation into the effect of microcomputer use in Canadian classrooms. The authors found that technology use seemed to preference small-group instruction, which resulted in some subject areas being more conducive to technology integration. The authors identified these differences as *culture clashes*. Culture clashes were based on whether teachers believed technology integration was compatible with their subject area (Goodson et al., 1995).

Over the past two decades, other research has come to similar conclusions that values and norms of some subject areas fit better with computers, suggesting fundamental components of the subject area may match or clash with technology integration. Hennessy et al. (2005) found that teachers in some subject areas exhibited a greater commitment to integrating ICTs in their practice. For example, they found that Science teachers felt use of ICTs could support, or even replace, laboratory activities. Yet, English teachers were concerned that ICTs 'seemed to contradict core values of the subject culture' (Hennessy et al., 2005, p. 23). A more recent study looking at Australian secondary teachers' computer use identified differences in frequency of use and perceived value of computer use in English, Mathematics and Science (Howard et al., 2015). Between 2010 and 2012, researchers found that use in Science and Mathematics decreased, but increased in English. Results showed

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