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# Does technology have an impact on learning? A Fuzzy Set Analysis of historical data on the role of digital repertoires in shaping the outcomes of classroom pedagogy



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## ABSTRACT

In the UK, 2012 marked the tenth anniversary of the publication of the Impact 2 report, which aimed to evaluate the relationship between school pupils' ICT experience and their attainment. Whether and to what extent digital technologies actually have impacts on school pupils' learning are questions which still do not have clear answers. Taking the micro-level of everyday classroom activities as the locus of the study, this paper aims to examine appropriate methodological approaches to evaluating the conditions which enable teachers and learners to use digital technologies for pedagogical goals. Using the notion of teachers and learners' digital repertoires, those taken for granted practices developed over a period of time, as its unit of analysis, the paper applies Fuzzy Set techniques to data from Becta Measures of Attainment Survey (2003). Arguing from systemic and empirical sources, the paper shows how the historical data is relevant in mapping out the factors which enable teachers and learners to achieve (or otherwise) their desired pedagogical outcomes. Taking two cases in which pedagogy either makes use of digital repertoires to achieve curricular aims or develops learners personal repertoires, the paper indicates the need for schools to be systematic in their tracking of pupil's digital experiences, and discusses the relevance of Fuzzy Set Analysis as a methodological approach.

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## 1. Introduction

In the UK, 2012 marked the tenth anniversary of the publication of the Impact 2 report, which aimed to evaluate the relationship between school pupils' ICT experience and their attainment (Comber et al., 2002). It followed an investment by the UK government, estimated at over a billion GB pounds, in hardware, infrastructure, staff training, and the establishment of an agency to manage digital technology in schools. One of the three strands in the evaluation was a statistical analysis of the relationship between time spent using ICT across all school subjects, and the outcomes of education as measured by high-stakes test results, using a quasi-experimental design. Opinions differ as to the value of this type of approach in evaluating the "effect" of using digital technologies from both champions and sceptics. It is recognised that searching for a causal explanation needs to take into account the wide range of practices, contexts and expectations that have arisen around attempts to embed digital technologies into a diversity of school cultures. However, evidence over the past forty years indicates that the consequences of these embeddings are complex, often with unpredictable and inconsistent outcomes resulting from the different understandings of the role of digital technologies in pedagogy (Cox, 2012; Law, Pelgrum & Plomp, 2008). Whether and to what extent digital technologies actually have impacts on school pupils' learning are questions which do not have clear answers. Which factors might be considered as "impacts" and how can they be measured, particularly when the role of context in terms of pedagogy, curricular requirements and available technology are taken into account?

Taking the micro-level of everyday classroom activities as the locus of the study, this paper aims to examine appropriate methodological approaches to evaluating the conditions which enable teachers and learners to use digital technologies for pedagogical goals. Using the notion of teachers and learners' digital repertoires as its unit of analysis, the paper applies Fuzzy Set techniques to map out the factors which enable them to achieve (or otherwise) their desired pedagogical outcomes (Rihoux & Ragin, 2008). Section two of the paper provides a

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background to the discussion about evaluating the link between the use of digital technologies and pedagogical outcomes. It presents a rationale for using Fuzzy Sets and the notion of digital repertoires as a model of the technological “know-how” which teachers and learners bring with them to classroom activities. Next, the paper introduces the Beta Measures of Attainment survey (2003) and the rationale for using this historical data for the analysis. The fourth section describes the construction of Fuzzy Sets which represent the digital repertoires, and the fifth section presents the causal analysis of the relationship between digital repertoires and the achievement of activity outcomes. The paper concludes with a discussion of FSA and the role of digital repertoires in schooling.

## 2. Background

Considerable amounts of time, money and energy have been expended on the introduction of digital technologies into classroom activities since the early nineteen eighties (Cox et al., 2004; OECD, 2008; Pelgrum & Plomp, 1993; Plomp & Voogt, 2009; Somekh, 2000). Given these major investments, a legitimate question raised by policy makers, school leaders, teachers and parents is whether and to what extent digital technologies make a difference to educational outcomes. However, what these outcomes are and how they are evaluated are the primary issues which need to be considered. As Cox (2012) points out, the range and nature of pupils’ experiences with digital technology in schools has changed since the introduction of the “Personal Computer” into schools in the nineteen eighties. Although school aged children encounter digital technologies in a variety of contexts, both in and outside school, it is their use for pedagogical purposes in everyday classroom activities which is the focus of this paper. Underlying this approach is the belief that the evaluation of whether and to what extent digital technologies have an impact on the outcomes of pedagogy should be situated within the dynamic relationship between teachers and learners (Higgins, Xiao & Katsipataki, 2012). Part one of this section discusses the methodological issues associated with evaluating the relationship between pedagogical practices and outcomes using digital technologies, before providing the rationales for using digital repertoires as the unit of analysis and Fuzzy Sets as an appropriate method for analysing them in parts 2 and 3.

### 2.1. Methodological issues

Two broad approaches to evaluating the roles of digital technologies in pedagogy can be identified, which reflect different methodological assumptions. There are those studies which focus on measurable outcomes of digitally-based pedagogy and tend to use quantitative methods, often retrospectively. Other evaluation studies focus on pedagogical processes and use qualitative methods to investigate them. In the UK, both approaches have been used for large-scale evaluations studies such as Wood et al. on Integrated learning Systems (1999), Impact 2 (Harrison et al., 2002), and the Test Beds study (Somekh et al., 2007). Other studies have examined the relationship between learners’ attainments and the introduction of specific technologies such as IWB (Higgins, Beauchamp & Miller, 2007; Moss et al. 2007). Machin, McNally and Silva (2007) analysis of the relationship between capital investment and primary pupils’ performance showed gains in English and Science but not mathematics at aged 11. In part this reflects the fit between what technologies can offer and what the curriculum requires pupils to do between the ages of 7 and 11 years old. Underwood (2009) draws on both qualitative and quantitative approaches to summarise the evidence for the positive impact of digital technologies on pupils’ outcomes. She makes the point that there is greater integration of digital technologies into the home, and this can have an impact on pupil’s attainment. International surveys sound a note of caution, however, for both pedagogical and methodological reasons. Balanchett, Blamire & Kefala, (2006) questions whether schooling should be restructured to take account of what technology can offer, implying that there is a mismatch between the current school curriculum and the opportunities offered by digital technologies. Methodologically, Scheuermann & Pedró (2009) expresses some scepticism about finding causal explanations using correlational techniques, for both practical and theoretical reasons (i.e. correlation is not causation). Higgins et al., (2012) make a connected point by examining the implication of the assumption that digital technologies may be identified as the independent variable, with changes in attainment as the dependent variable in such evaluations. They argue that the quality of the school context may be the key factor, with success in high stakes exams and use of digital technologies as consequences. Cox & Marshall (2007) point to a range of factors which need to be clarified in connection with these questions including what the focus ought to be in evaluating impacts, and which methodological approaches are appropriate.

Although correlational studies tend to use a model of causality based on a quasi-experimental approach since this is regarded as “the gold standard” in scientific research, there are compelling reasons for regarding this as inappropriate for educational research (Raudenbush, 2008). Large-scale studies necessarily smooth out the differences between different contexts in order to investigate links between using digital technology as an independent variable, with learning outcomes assumed to be the dependent variable. However it is the role of contextual factors in educational settings that are significant for shaping the ways in which digital technologies are used. An emergent trend in trying to assess the “impact” of digital technologies on learning is the recognition of the need to study actual classroom uses of digital technologies, which take into account the wide variety of beliefs, practices and contexts shaping learning outcomes. (Harrison et al. 2002; Law et al., 2009; Somekh et al., 2007; Wood et al., 1999). Qualitative methods have been used to show positive results in interventions with a focus on the links between process and outcomes (Cox et al., 2004; Underwood, 2009). By definition these studies are undertaken by those with a commitment to the use of digital technology, and it is not clear whether they could be replicated with different contexts and personnel.

Naturally these studies do assume that digital technologies are an element within the unfolding dynamic of pedagogical activities, and they may be interpreted and used in different ways by teachers and learners. Capturing how teachers and learners interpret and use digital technologies is an important aspect of their dynamic interaction in pedagogical settings. Assessing the “impact” of digital technologies on the achievement of pedagogical outcomes is viewed in this paper as examining the extent to which the interaction between teachers and learners’ digital repertoires, those taken-for-granted routines gained through the use of technology in a range of contexts, condition the outcomes of activities.

It is important to stress that “condition” is not the same as “determine”; they imply different models of explanation. Examining the factors which condition a given event involves finding which are necessary or sufficient for the event to occur. These factors do not determine an event, but provide an assessment of what is likely to be relevant for a given event to occur. Fuzzy Set Analysis (FSA) provides the means to make this kind of analysis and will be introduced and discussed in the third part of this section. Together, digital repertoires

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