4 DEVELOPMENT OF AN OBSERVATION METRIC FOR LINKING PEDAGOGY, TECHNOLOGY AND SPACE

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ABSTRACT

The current interest in innovative learning environments has generated considerable investment in spaces designed to transgress the boundaries of learning set by an 'architectural deterministic' mindset. Such a mindset assumes that the act of occupation of these spaces itself will cause the desired change to teaching and learning. However, a design-orientated approach often neglects to monitor what actually happens once these spaces are inhabited. The evidence base is yet to show how these spaces invoke pedagogies that support the desired types of learning that the design was intended to support. Because there are relatively few methodologies and metrics available to measure the impact of the space on pedagogy in situ, the Linking Pedagogy, Technology, and Space (LPTS) observational metric was developed. The LPTS metric provides instantaneous visual feedback to teachers on their practice and tracks its subsequent impact on their students. This paper reports on the conceptual development of the metric.

KEYWORDS: SINGLE SUBJECT RESEARCH DESIGN, CLASSROOM OBSERVATION, EMPIRICAL EVIDENCE, INNOVATIVE LEARNING ENVIRONMENTS, TEACHER DEVELOPMENT.

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INTRODUCTION

It is an assumed truism that teachers' utilisation of space makes a difference to pedagogy, which therefore must impact on student learning outcomes (Joint Information Systems Committee, 2006). Brooks (2011) and Stadler-Altmann (2015) claim that there is currently limited empirical evidence to support adequately such a claim (for exceptions see Brooks, 2011; Byers & Imms, 2016; Byers, Imms, & Hartnell-Young, 2014; Imms & Byers, 2016). This lack of understanding stems from the fact that teaching and learning is a profoundly complex and contextual field (Boddington & Boys, 2011; Lee & Tan, 2011; Woolner, McCarter, Wall, & Higgins, 2012). There is currently an absence of rigorous experimental methodologies (Painter et al., 2013) that have been able to delineate adequately between the architectural and physical affordances of spaces and how these affect the teaching and learning (Gislason, 2010).

Much of the evaluative frameworks around ascertaining the impact of contemporary or innovative learning environments has focused on identifying those physical or tangible aspects of the spatial design that are optimal for student learning (Blackmore, Bateman, O'Mara, & Loughlin, 2011). The work by Barrett and Zhang (2009) and Barrett, Zhang, Moffat, and Kobbacy (2013) established those tangible elements of the physical environment that are optimal for student learning. However, exactly what happens when teachers and student occupy these different learning environments and how this affects the teaching and learning are yet to be determined with any degree of certainty. There is little evaluation tracking how teachers and students navigate the significant spatial transitions from conventional classrooms to innovative learning environments. Thus, it is unclear if, and how, the occupation of such environments realises the envisioned changes to teacher pedagogy and student learning experiences and outcomes.

The development of the LPTS real-time observation metric sought to provide a mechanism for providing empirical evidence that could evaluate the impact of spatial interventions on key aspects of learning and teaching. The design of the LPTS observational metric as a macro-enabled Microsoft Excel program accommodates recording and compilation of data, and then the production of a visual representation of the proportional breakdown of the observed lesson in terms of time spent on every activity across five domains (pedagogy, learning experiences, communities of learning, and student and teacher use of technology). When applied through a quasi-experimental approach, facilitated by a Single Subject Research Design (SSRD), the metric tracks and then compares the degree of change of the same student and teacher (as a class) activity and behaviours in different spatial settings (intervention) through the collection of repeated measures. Through the collection of repeated quantitative measures of the same class (unit of analysis) through the independent variable of time, the metric seeks to reduce the influence of observer inference (Clarke et al., 2006). At the same time, the real-time visual data produced by the metric can be shared with teachers as a means of feedback to enable them to understand their practice through continuous and in-situ professional development.

REVIEW OF CLASSROOM OBSERVATIONAL APPROACHES

Classroom observations have been a ubiquitous element of both teacher appraisal (Stronge, 2006) and profession development (Warwick, Vrikki, Vermunt, Mercer, & van Halem, 2016; Wragg, 2013). Done well, they can benefit both the observer and the teacher observed, and can enhance the collective professional skill set at the particular school (Wragg, 2013). O'Leary (2012) writes that *teacher effectiveness* has become a common theme of the current focus on the use of observations. Authors have attempted to link teacher effectiveness as one of the mediating factors that impact student achievement (Campbell, Kyriakides, Muijs, & Robinson, 2004; Danielson & McGreal, 2000; Montgomery, 2002).

As the conception of student learning has changed, so too has the view of the quality teaching (Danielson & McGreal, 2000). Historically, classroom observations have been seen as a relatively blunt process undertaken by an administrator who measures teacher performance against subjective rating scales (Danielson & McGreal, 2000). These 'snapshots' evaluations of teacher practice are often more like a test, with little opportunity for reciprocal dialogue and top-down feedback provided. In many instances, this process has been galvanised under the recent accountability and policy frameworks. Frameworks, such as the *Australian Institute for Teaching and School Leadership (ATSIL), Office for Standards in Education (Ofsted – the UK) No Child Left Behind* (USA), favour standardised and systematic teacher appraisal and lesson evaluations as an authentic way to ascertain classroom practices and processes (Stronge, 2006; Wragg, 2013). The nature of these top-down accountability reforms has reinforced classroom observations as the dominant measure of teacher quality in recent years (O'Leary, 2012; Pianta & Hamre, 2009).

Given the growing importance placed on the evaluative capacity of classroom observations, the work of Wragg (2013) has highlighted the importance of the reliability and validity of the process and metrics around observations. Wragg is critical of observational practices that are largely subjective activities (O'Leary, 2012), with the assessment of teachers construed through the "interpretative lens of the observer" (Foster, 1996, p. 14). Here the assessment of what is 'good' or 'bad' resides more in the subjective judgement of the observer, rather than what is observed (Wragg, 2013). Also, these more subjective forms of appraisal are often influenced by the tautology of "proxies of degrees or experience" that correlate to student learning outcomes as a measure of teacher effectiveness (Pianta & Hamre, 2009, p. 109). Pianta and Hamre (2009) suggest that more objective, standardised approaches to classroom observations move the historical measures of teacher quality to a more reliable and valid status.

Empirical approaches have the potential to demonstrate the continuing professional growth of teachers over time through the longitudinal evaluation of classroom observation data. However, to be an effective professional development tool, they cannot be one-off snapshots of practice (O'Leary, 2012; Pianta & Hamre, 2009) nor involved hierarchical grading systems (Wragg, Wikeley, Wragg, & Haynes, 1996). In their longitudinal study, Wragg et al. (1996) found that one-off observations were unable to identify incompetent teachers, as many rehearsed lessons to avoid detection. Wragg et al. (1996) concluded the need for a series of observations carried out over an extended period so that a fair and more genuine picture of a teacher's competency in the classroom can be constructed. Further to this, the Wragg et al. (1996) study also found that the consistent and uniform interpretation of grading systems, and the assessment criteria that underpin them, led to inter-rater reliability issues. Finally, the climate around the observation is critical to foster professional conversations post the feedback (Danielson & McGreal, 2000).

CLASSROOM OBSERVATIONAL TOOLS

The recent emphasis on empirical data and evaluation in education has led to the development of various classroom observation metrics, tools, and systems. The *Enhancing Professional Practice: A Framework for Teaching* (Danielson, 2011), *Classroom Assessment Scoring System* (or CLASS) (Pianta, La Paro, & Hamre, 2008), *Practical Observation Rubric To Assess Active Learning* (or PORTAL) (Eddy, Converse, & Wenderoth, 2015) and *Reformed Teaching Observation Protocol* (Sawada & Piburn, 2000) represent tools with a specific focus on teacher pedagogical practices. Of these tools, Danielson's (2011) framework has enjoyed the greatest systemic implementation, as it is considered to "encompass the essential components of the teaching practice" (Elmendorf & Song, 2015, p. 3). Collectively, these tools reflect the trend towards the utilisation of classroom observations, with responsive integration and improved feedback mechanisms, to better support teacher growth and development through a greater emphasis on formative evaluation (Danielson & McGreal, 2000).

There are a smaller number of observational tools that focus on the integration of technologies in the classroom. The *Integration of Technology Observation Instrument* (Arizona State University West, 2002), *Observation Protocol for Technology Integration in the Classroom* (or OPTIC) (Northwest Regional Educational Laboratory, 2004) and the *International Society for Technology in Education (ISTE) Classroom Observational Tool* (or ICOT) (Bielefeldt, 2012). The design and function of the ICOT enabled the observer to collect real-time "information on setting, student groupings, learning activities, teacher roles, and time and type of technology use" (Bielefeldt, 2011, p. 3). The ICOT, aligned with ISTE's *National Educational Technology Standards for Teachers* (NETS-T) provided a novel approach in the use of timed activity to measure "teaching practices for designing, implementing, and assessing student learning, engagement, and improvement" (McPherson, 2009, p. 5). The ICOT represented a move away from the provision of observation feedback by standardised and static rubrics. Its dynamic timekeeping design afforded an observer a means by which to evaluate the extent to which are students engaged in learning and the pedagogical advantage associated with the integration of empirical data by way of digital technologies (Hayden, Ouyang, Scinski, Olszewski, & Bielefeldt, 2011).

Of the classroom observational tools reviewed, there were none that focused on the impact of the physical learning environment on teachers and students. As a consequence, the review was extended to the literature surrounding *Post Occupancy Evaluations* (POE), as some approaches integrate observations as a data collection approach. Hadjri and Crozier (2009) define a POE as a "process that involves a [rigorous] approach to the assessment of both the technological and anthropological elements of a building in use" (p.22). Within the literature surrounding POEs, the works of Finch (1999) and Whitemyer (2009) suggest the use of observational methodologies as a replacement to the use of questionnaire or survey methods often found in the POE process. The observation process, similar to that of an ethnography, provides a higher definition account of how people interact with the built environment and the manner in which it supports, or curtails envisioned activities and behaviours of its occupants (Hadjri & Crozier, 2009; Whitemyer, 2009).

LINKING PEDAGOGY, TECHNOLOGY, AND SPACE METRIC DEVELOPMENT

The notion of the LPTS observational metric was derived from the quasi-experimental studies using an SSRD that investigated the impact of different learning spaces on teachers and students (see Byers, Hartnell-Young, & Imms, In review-a; Byers & Imms, 2014; Byers & Imms, 2016; Byers et al., 2014; Byers, Imms, & Hartnell-Young, In review-b; Imms & Byers, 2016). These studies identified trends that suggested a tangible link between the occupation of innovative learning environments and improvements in student attitudes to various aspects of their learning that manifested as academic gain. Even though these earlier studies produced sound empirical evidence that advanced the possible relationship between the different spaces and their impact on teaching and learning, the deeper analysis suggested that space was the only factor in this relationship (Imms & Byers, 2016).

The cumulative evidence indicated that the pedagogical impact of the various learning spaces was not a simple cause and effect relationship. The evidence suggested the classroom teacher was a mediating influence. Moreover, the transition from the conventional or traditional classroom space to a more ILE space benefited those teachers who are able and/or willing to align the affordances of the physical learning environment with the potential of digital technology and pedagogy more purposefully (Byers et al., In review-a; Byers et al., In review-b; Imms & Byers, 2016). For others, however, the spatial transition did not have a tangible impact on their teaching practice from their students' perspective, and little change in their learning outcomes was evident (Byers et al., In review-b). It seems that it was primarily the ability of individual teachers to harness the digital and physical affordances of particular spaces that

had a significant bearing on the resulting pedagogical effectiveness. It is this pedagogical change that had altered student learning experiences by having a statistically significant impact on student engagement and consequently, learning outcomes (Byers et al., In review-a; Byers et al., In review-b; Imms & Byers, 2016).

The inconsistent effects at different stages as evidenced by a significant number of teachers, made it clear that a better understanding of how, and to what effect, teachers navigate the spatial transition was of importance. At the time, the literature review of Blackmore et al. (2011) suggested that little attention had been directed to developing means to track teachers and students' inhabitation of an ILE in order to ascertain its pedagogical impact. The mediating role of the classroom teacher was identified by Lackney (2008) in the concept of teacher *environmental competency*. Lackney suggested that the ability of teachers to effectively utilise the physical learning environment for pedagogical advantage is varied. The differences in teacher environmental competency could underlie the argument that a spatial change does not equate to an automatic change in pedagogies (Cleveland & Fisher, 2014; Hattie, 2009; Hattie & Yates, 2014; von Ahlefeld, 2009). With little evaluation of the impact of teacher environmental competency on learning outcomes done or available, particularly in regard to the transition from conventional to innovative learning spaces, it is unclear if, and how, the envisioned pedagogical changes theorised to occur as a consequence of the adoption of an ILE are actually realized in practice (Blackmore et al., 2011; Mulcahy, Cleveland, & Aberton, 2015; Willis, Bland, Hughes, & Elliott Burns, 2013).

CONCEPTUAL DEVELOPMENT

To better understand how the occupation of different learning environments impacted upon teachers and students, it was essential to track their activity and behaviour in each setting. A qualitative descriptive account of behaviour was considered untenable because of the myriad of actors and interactions that take place in a typical classroom and the issues associated with keeping track of all of them. As a result, the LPTS metric is designed to enable a single observer the capacity to record the time spent on a targeted activity. Furthermore, the use of a more quantitative approach is likely to improve the objectivity of the observation by reducing the potential influence of observer inference (Clarke, Keitel, & Shimizu, 2006).

The quantitative nature of the design of the LPTS metric was informed by both the Learner's Perspective Study (Clarke et al., 2006) and ICOT tool (Bielefeldt, 2012). These earlier examples employed a more numerical approach to tracking the difference in activities and behaviours in specific situations. In a similar vein to the ICOT, the LPTS uses the timed breakdown of activity and behaviours distinguishing it from other approaches that use standardised criteria or rubrics. On the other hand, unlike the observation protocol of the ICOT tool, with which the observer records teacher and student activities in a cyclic 3-minute pattern (Bielefeldt, 2012), the design of the LPTS metric enables a more real-time or live recording of what occurs in the observation.

OBSERVATIONAL INTERFACE

The use of a macro-enabled Microsoft Excel (Figure 1) provides the ability of a single observer to time the activity and behaviours associated with five domains: pedagogy; learning experiences; communities of learning; and student and teacher use of technology. The metric uses a simple checkbox system to record the duration of time of an observed activity or behaviour. When the observer sees a particular activity and/or behaviour, they simply click on the associated checkbox, which starts a corresponding timer/stopwatch. When that activity and/or behaviour ended, they click the box again, stopping the timer/stopwatch. At this point, the macro-enabled feature of the metric adds the recorded duration and produces a cumulative time at the end of the observation.

At the conclusion of the observation, the LPTS metric uses a three button process to collate the total duration of the lesson observation and various activities and behaviours in each of the domains; calculate the proportion of each against the length of the observed lesson and clear the data from the observational interface.

Figure 1: Linking pedagogy, technology, and space observational metric (version 1) user interface.

ANALYSIS

For easy interpretation and comprehension, the design of the LPTS metric produced a single and/or paired observation visual breakdown in the form of bar graphs (Figure 2). Using a simple drop down menu, the observer could easily access any of the recorded observations. This design feature enables the observer to readily share a single observation or series of observations with the observed teacher.

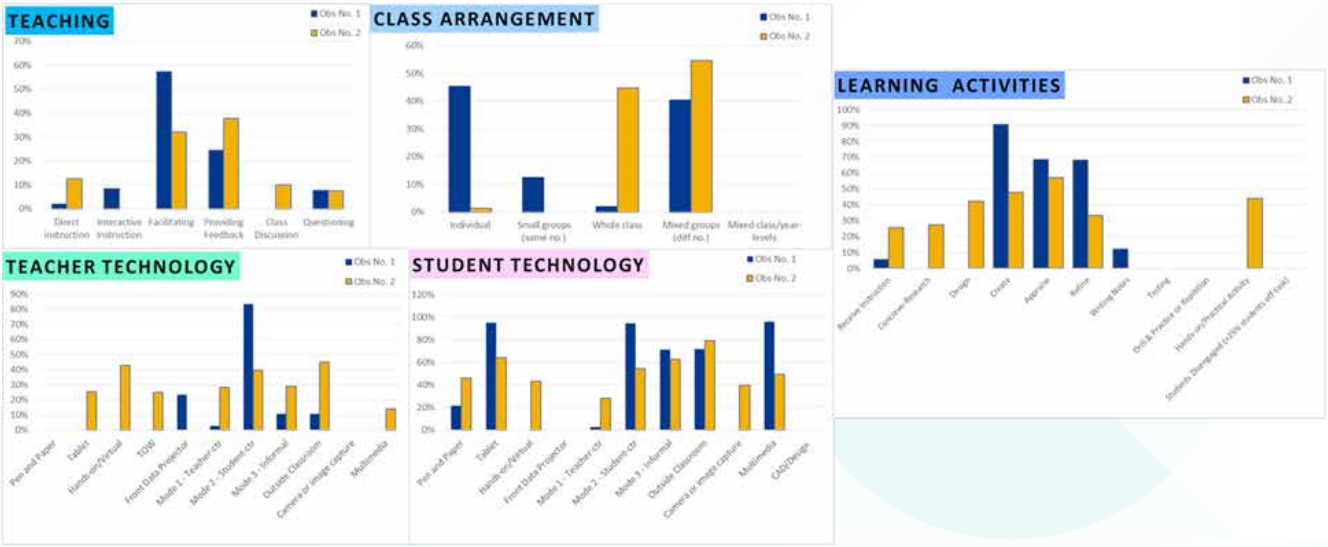

Figure 2: Linking pedagogy, technology, and space observational metric (version 1) visual output.

The metric's design enabled a single observer to collate numerous observations of the same teacher, Faculty and school. The collation of data over repeated observations (or measures) provided the ability to engage a Single Subject Research Design (SSRD) approach to the subsequent analysis. The nature of the data collected by the metric enabled the combination of conventional visual analysis and *Tau-U*

calculations. In combination these means of analysis could identify the occurrence of functional and sustained changes in activities and behaviours over a series of observations. Furthermore, the addition of either a time-series A (Baseline)-B (Intervention) or A (Baseline)-B (Intervention 1)-C (Intervention 2) afforded the opportunity to measure the change in learning space (independent variable) on the communities of learning, learning experiences, pedagogies, and technology usage (dependent variables) over the same group of teachers over a extended period of time (Byers, 2015).

The combination of the visual and nonparametric (Tau-U) analysis provides the opportunity to engage in a statistically rigorous and reliable approach to the evaluation of the effect of spatial transition on teachers and students (see Byers, 2015). The application of visual analysis is a relatively common occurrence in SSRDs. The process seeks to identify statistically significant changes in activities and behaviour between phases (i.e. A-B, B-C, or A-B-C). The criteria used to determine them usually consists of observed changes in level; apparent trends; the immediacy of the effect and variation in effects observed (Byiers, Reichle, & Symons, 2012; Kratochwill, 2013). Examples of such observations are outlined in Figure 3. The visual analysis data displayed is from the observation of one teacher in a traditional setting (A); with same class in an Interactive Learning Environment (B); and with a different class in an ILE but following the same curriculum in phase A (C). The application of the criterion suggests that there was a significant change in the observed instances of Mode 1 (Teacher-Centric), Mode 3 (Informal) and Outside Classroom occupation in the B and C phases. However, the lack of visual change in the Mode 2 (Student-Centre) occupation between the A-B-C phases suggests no significant change occurred for this teacher.

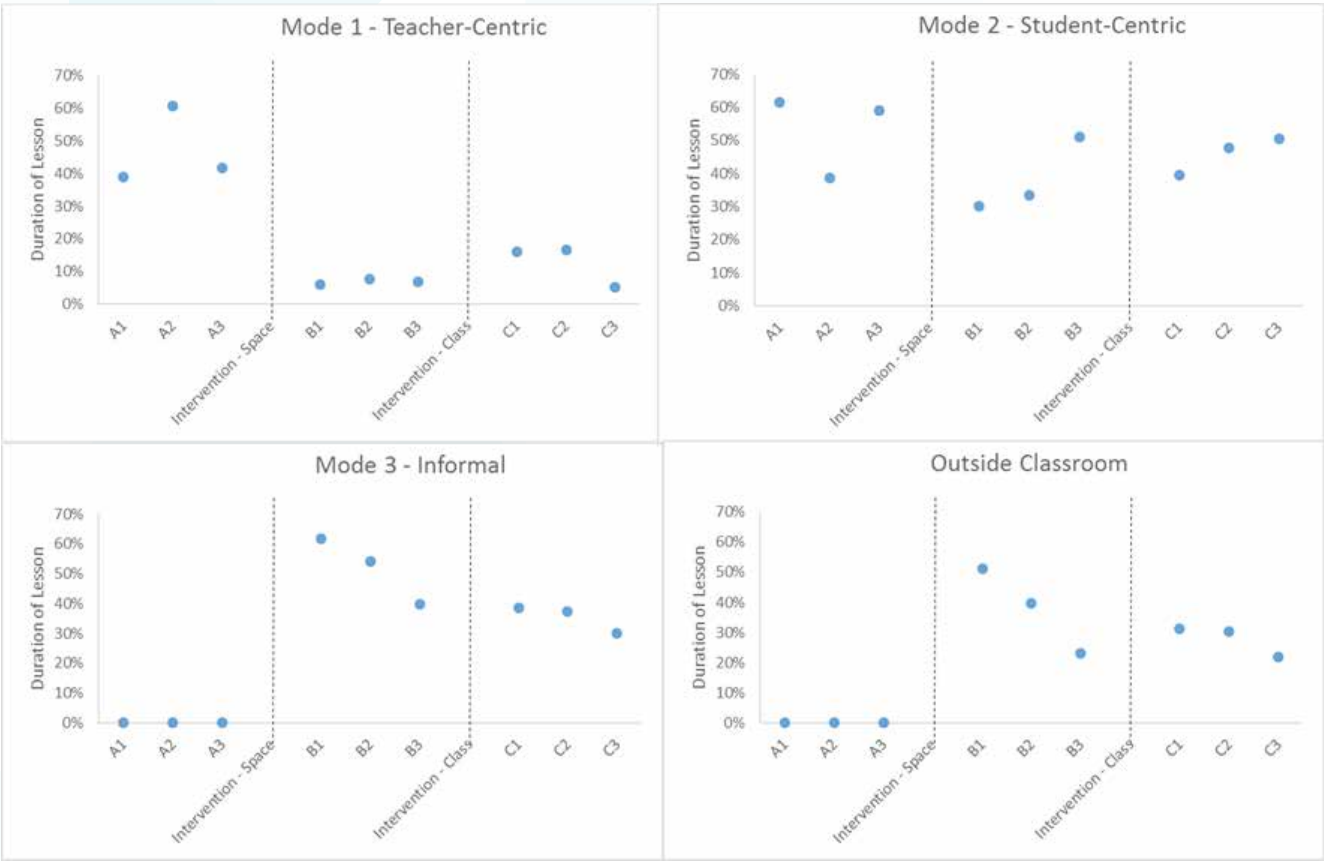

Figure 3: Examples of the Visual Analysis process from an A-B-C study using the Linking Pedagogy, Technology, and Space Observational Metric.

Tau-U analysis provided a measurement of the degree of non-overlap between the phases to justify the decisions of the visual analysis (Parker, Vannest, Davis, & Sauber, 2011). Tau-U calculations suited the non-conforming nature and the absence of distribution norms typical of small sample size observational studies. Each of these issues violated the assumptions (i.e. constant variance, normality, power, and serial dependency) of traditional regression-based (i.e. ordinary least squares) approaches (Rakap, 2015; Wolery, Busick, Reichow, & Barton, 2010). The Tau-U method is based on the sampling distributions employed by the Mann-Whitney U and Kendall's Rank Correlation, resulting in p-values and CIs (Parker et al., 2011). Unlike simpler non-overlap techniques, it provides control for a trending baseline phase (Parker et al., 2011; Rakap, 2015). For this purpose, the repeated measures data from each phase was entered into the Tau-U calculation, with resulting p-values produced to indicate whether statistically significant changes occurred between the relevant phases. Furthermore, the application of weighted average in Tau-U calculations enables the observer to compare between different phases (i.e. A-B and A-C phases) (Parker et al., 2011). The application of weighted averages provides the opportunity for the observer to evaluate short- and longer-term effects of occupying different learning spaces.

PILOT TESTING

Before the application, the LPTS metric was piloted by three observers. Using the recommendations made by Bielefeldt (2012), the chi-square frequencies were calculated on the lesson breakdown of 9 teachers (not participants in this study) by three observers on a total of 18 occasions. There were no statistically significant differences ($p > .05$) in the times recorded for the five domains. This pilot testing suggested the LPTS metric had adequate interrater reliability, similar to that found by Bielefeldt with the original ICOT tool (Bielefeldt, 2012).

CONCLUSION

The premise underpinning the current interest in ILEs is the assumption or claim that they will facilitate a desired pedagogical change. However, there has been limited empirical evidence showing how these spaces have caused the envisioned change. In many instances, the lack of substantiation stems from the limited number of empirical metrics able to ascertain the quantitative impact of different learning environments. The LPTS metric seeks to address this shortfall both in its design and use and the quantitative analysis of the resulting data.

The initial testing and application of the LPTS observation metric, analysed through an SSRD approach, shows that it has the potential to evaluate teacher and student experiences in different learning spaces (see Byers, 2015). However, to improve the generality and validity of both the approach and the metric, a longer-term evaluation of teacher change and the effects of different contexts/spaces is required.

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