

RESEARCH

The Case for Measuring Adults' Numeracy Practices

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Abstract

In this article, we make the case for the development of a numeracy practices measure in the light of a review of relevant research and extant measures. We argue that a numeracy practices measure would acknowledge and validate adult learners' practice gains and inform teaching geared to their circumstances, needs and interests.

In New Zealand, there is a robust infrastructure supporting adult literacy and numeracy education and training. Professional development is built around the "three knowings": know the learner; know the demands; know what to do (National Centre of Literacy & Numeracy for Adults, 2011). Learners' progress is measured by an online adaptive proficiency measure, the Literacy and Numeracy for Adults Assessment Tool (TEC, 2016). Adult numeracy learners often mention to their tutors that since joining a program they work out the cost of shopping, help their children with their mathematics homework, or perform work calculations and estimations that they previously avoided. However, these "practice" gains may not be reflected in improved scores on proficiency assessments, to the frustration of tutors and learners alike. In response, we undertook a project scoping the development of a measure of adults' numeracy and literacy practices for the New Zealand

Ministry of Education. Our challenge is to find a way of measuring such practices in a robust, evidence-based, culturally-sensitive, ethical, practicable, and cost-effective way, in order to inform teaching and recognize learning.

Here we outline selected aspects of our work. We present a review of relevant literature and set out the case for a measure of adults' numeracy and literacy practices before briefly reviewing a selection of existing measures which encompass elements of numeracy and literacy practice measurement, and recommending ways forward.

Measuring Numeracy and Literacy Practices

The idea of measuring numeracy and literacy practices is gaining traction in various places around the world. For example, in the United States, Reder (2013) argues that measuring engagement with numeracy and literacy practices would be a good way of tracking change during and after engagement with learning programs, complementing proficiency measures. Similarly, Esposito, Kebede, and Maddox (2012, p. i), in Mozambique, contend that "measuring preferences and weighting of literacy practices provides an empirical and democratic basis for decisions in literacy assessment and curriculum development, and could inform rapid educational adaptation to changes in the literacy environment."

Our focus in this article is primarily on numeracy, and we are mindful of the fact that terminology around numeracy is complex (Coben et al., 2003). Numeracy is often treated as an aspect of literacy in research and policy literature, with scant regard to its particularities. We contend that numeracy should be taken seriously on its own terms, with an equal, rather than a subservient relationship to literacy (Coben, 2006, p. 103). Accordingly, where it is necessary to consider both numeracy and literacy in this paper

we have chosen to reverse the normal order (i.e., "literacy and numeracy") to emphasize this point. This is in keeping with numeracy's emergence onto the international stage in recent years. For example, "quantitative literacy" was specified as one of "three domains of literacy skills" in the Organization for Economic Cooperation and Development's (OECD's) International Adult Literacy Survey (IALS) in the 1990s (OECD & Statistics Canada, 2000, p. x) but more recent international surveys of adult skills have specified "numeracy" as an information processing skill in its own right. The definition of numeracy in the latest such survey, the Survey of Adult Skills in the Program for the International Assessment of Adult Competencies (PIAAC) is one we find helpful because of its orientation towards practice:

Numeracy is the ability to access, use, interpret, and communicate mathematical information and ideas, in order to engage in and manage the mathematical demands of a range of situations in adult life. (PIAAC Numeracy Expert Group, 2009, p. 55)

The focus on use and engagement in the PIAAC definition of numeracy is somewhat at odds with the focus in much of the policy literature on adult numeracy and literacy as technical skills producing human capital outcomes (Keeley, 2007; Sen, 1997). Street (1984, p. 29) terms this the "autonomous model," which he characterizes as "supposedly technical and neutral." By contrast, the academic literature on adult numeracy and literacy is weighted towards a social practice perspective (Street, 1984; Tett, Hamilton, & Hillier, 2006). This perspective aligns with what Street calls the "ideological model," in which literacy is seen as culturally-sensitive, context-dependent and embedded in power relations. Proponents of this approach tend to value social capital (Bourdieu, 1976) as an intended outcome of public policy. Debate is

polarized at best; at worst, it is absent. We cross this divide. We see numeracy and literacy as both social practices and technical skills, productive of both social and human capital. We agree with Schuller (2001) that these forms of capital have complementary roles in lifelong learning. He contends that the use of social capital opens up possibilities for the exploration of contemporary paradoxes, such as: the dominance of individual choice; policy consensus on the importance of lifelong learning; demands for accountability and evaluation in the public sphere; and technically more sophisticated measurement methodologies. The last of these is particularly relevant to our project scoping the development of a measure of adults' numeracy and literacy practices. We are interested in what adults do with their numeracy and literacy in a range of contexts, thus, our approach fits within a social practices perspective.

The emergence of a social practices perspective on numeracy and literacy is an example of the "practice turn" in contemporary social theory (Knorr Cetina, Schatzki, & von Savigny, 2005). Writing in this mode, Schatzki (2012, pp. 14-15) describes practice as "an open-ended, spatially-temporally dispersed nexus of doings and sayings" that takes place in a teleological hierarchy for which the "practicer" has an end in view. He contends that "A practice embraces all the activities contained in such teleological hierarchies: the activities and states of existence for the sake of which people act, the projects, i.e., actions they carry out for their ends, and the basic doings and sayings through which they implement these projects." Furthermore, "a practice's activities are organised by practical rules, understandings, teleoaffective structures, and general understandings." We consider practice in this light.

Practice necessarily takes place in a particular situation so we want to measure 'situated practice' (Balatti, Black, & Falk, 2006; Hutchings, Yates, Isaacs, Whatman, & Bright, 2012; Reder, 2008). Practice is

also goal-directed, since adults are likely to have a reason for improving their skills (Stewart, 2011; Waite, Evans, & Kersh, 2014). These goals may be extrinsic, such as to improve skills for work, at home or in the community, or intrinsic: for self-improvement. For example, adult numeracy learners in England stated that they attended classes: "to prove that they have the ability to succeed in a subject which they see as being a signifier of intelligence; to help their children; and for understanding, engagement and enjoyment;" goals such as gaining a qualification or coping better with mathematics in everyday life were a minor incentive (Swain, Baker, Holder, Newmarch, & Coben, 2005, p. 9). Following Schatzki (2012), we characterize numeracy and literacy practice as an open-ended, situated, spatially-temporally dispersed nexus of goal-directed doings and sayings involving numeracy and literacy.

Social practice theories of adult numeracy and literacy take a number of forms (Perry, 2012) and draw on a range of disciplines with a correspondingly wide variety of methodologies. For example, the "new literacy studies" (NLS) developed by Street and others (Hull & Schultz, 2001) draw mainly on sociology, socio-linguistics and anthropology and favor ethnographic approaches. As the name suggests, NLS is stronger on literacy than numeracy, as Street's (2003) review attests. Lave and Wenger's (1991) theories of situated cognition and communities of practice draw on social anthropology and psychology, while cultural historical activity theory (CHAT) (Engeström, 2001) draws on the work of the psychologists Leont'ev (1969/1995) and Vygotsky (1962, 1978). Reder's (1994) practice-engagement theory also draws on Vygotsky. Reder contends that literacy skills and reading practices develop best within specific practice contexts. Practice-engagement theory specifies the relationships between "expressed literacy choices/preferences and perceived social meanings" in a

detailed, practice-specific way, emphasizing “the patterns of individuals’ access to and participation in various roles within as well as across cultural groups” (Reder, 1994, p. 59). It acknowledges the possibility of continued development or decline of numeracy and literacy skills in relation to the affordances of any given situation and the individual’s use of numeracy and literacy.

Maddox and Esposito (2011, p. 1319) propose a “capabilities approach,” in which “literacy can be understood not simply as cognitive abilities or competencies, but as a set of ‘functionings’ (as beings and doings), or the potential to function.” They note that the concept of “literacy functionings” is similar to that of “literacy practices” in the ethnographic literature (citing Street, 1993), drawing attention to the social uses of literacy, and the production and embodiment of social identities.

These perspectives have generated corresponding methodologies and units of analysis. For example: for Vygotsky the unit of analysis is individual activity; for CHAT researchers it is the activity system (Engeström, 2001); for researchers working in a situated cognition perspective it is “practice,” “community of practice,” and “participation.” Street distinguishes between “literacy events” and “literacy practices” as units of analysis, such that literacy practices are the “broader cultural conception of particular ways of thinking about and doing reading and writing in cultural contexts” (Street, 2000, p. 11), whereas “literacy events” are discrete situations in which people engage with reading or writing (Heath, 1982). Similarly, Barton and Hamilton (1998) describe “literacy events” as activities in which literacy has a role. Purcell-Gates and colleagues (2000, p. 3) define literacy events as “the reading and writing of specific texts for socially-situated purposes and intents.” In this perspective, while literacy practices are unobservable, the associated literacy events are observable. This

distinction is problematic for numeracy since it may be invisible to those engaged in it (Coben, 2000; Keogh, Maguire, & O’Donoghue, 2012; Noss & Hoyles, 1996) and ‘numeracy events’ might or might not be observable, depending, for example, on whether someone uses a calculator, counts on their fingers or calculates mentally, or paces out a space rather than judging distance by eye.

As Reder (2016) notes, while social practices proponents have offered strong critiques of interpretive and policy frameworks reliant on standardised test scores alone, large scale practical alternatives have not been proposed. He argues that this is particularly problematic for the development of more effective adult numeracy and literacy programs which would benefit from richer measures of learner progress and program evaluations based on those measures. We are seeking to develop such a richer, technically more sophisticated measurement methodology, in Reder’s (2016) and Schuller’s (2001) terms. In the next section we set out the case for such a measure.

The Case for a Measure of Adults’ Numeracy and Literacy Practices

Our rationale for the development of a measure of adults’ numeracy and literacy practices is evidence-based, as follows.

1. The development of literacy and numeracy proficiency over time is strongly associated with adults’ engagement in literacy and numeracy practices.

There is evidence from the U.S. Longitudinal Study of Adult Learning (LSAL) and elsewhere that the development of adults’ numeracy and literacy proficiency over time is strongly associated with their engagement in numeracy and literacy practices, bearing out the prediction of practice engagement theory that engagement in numeracy and literacy

practice leads to growth in proficiency (Reder, 1994; Sheehan-Holt & Smith, 2000). LSAL found that “Adults at similar proficiency levels at one point in time wind up many years later at different proficiency levels depending in part on their earlier levels of engagement in literacy practices” (Reder, 2009, p. 47).

2. Educational programs that increase learners’ engagement in numeracy and literacy practices show improved outcomes for learners in terms of increased numeracy and literacy proficiency and future life benefits.

Of particular interest here is the direction of causality demonstrated by LSAL, where “The sequence of observed changes makes it clear that program participation influences practices rather than vice-versa” (Reder, 2008, pp. 3-4).

Similarly, research in New Zealand found that learners reported changes in their work practices stemming from their participation in a workplace program, including, for example:

“I don’t have to use my fingers. I can work out how many there are on a pallet [when multiplying rows of products]”

“I’m now working out the volume of concrete. The engineers used to come out, now they just double-check it.”

(Department of Labour, 2010, pp. 56-57)

In Canada’s UPskill initiative, Gyarmati et al. (2014) found that when workers developed their workplace numeracy and literacy skills they were able to transfer them into their wider family and community lives, showing improvements on behavioral and numeracy and literacy practice indicators.

PIAAC data also indicate a relationship between proficiency and practice in that:

adults who practice their literacy skills nearly every day tend to score higher (*sic*), regardless of their level of education. This suggests that there might be practice effects independent of education effects that influence proficiency.

(OECD, 2013, p. 212)

For Sticht (2013), the PIAAC results confirm “the three-way interaction of education, literacy skill, and engagement in literacy practices” which he terms the “triple helix’ of literacy development.” He explains this term as follows: “By this we meant that education produces some literacy skill, that leads to more practice in reading, which helps in the pursuit of more education, leading to more skill, leading to more engagement in reading, and so forth.”

The extent to which numeracy and literacy practices build from participation in programs is contingent on a range of factors. For example, using authentic contexts in learning programs increases the likelihood that there will be improvements in practices (Purcell-Gates, Degener, Jacobson, & Soler, 2002; Reder, 2008). Vaughan (2008) adds that learning must be meaningful for it to be practiced in a valued way. Adults need to use their learning in different contexts, transferring learning from education into other contexts such as the workplace, a process which requires time and support (Eraut, 2004). For numeracy, Evans (1999) notes that transfer is not dependable but neither is it impossible. He recommends designing pedagogic approaches that will facilitate transfer, building bridges between practices within and outside education. With such factors in place, educational programs may ‘jump-start’ adults into engaging in numeracy and literacy practices that

use and subsequently further develop their numeracy and literacy skills.

Accordingly, a practices measure would support teaching and learning that is more attuned to the type of engagement that research shows is effective in building proficiency over the long term (Reder, 2012). Engagement in numeracy and literacy practices is crucial if the numeracy and literacy of those with low skills are to improve and adults with the lowest numeracy and literacy skills have less opportunity than those with higher skills to perform workplace tasks that involve numeracy or literacy on a regular basis (Dixon & Tuya, 2010). These proficiencies are directly relevant to adults' prospects, wellbeing and quality of life (Reder, 2016). LSAL (Reder, 2012), UK research (Bynner & Parsons, 2009), and large-scale international adult numeracy and literacy assessments, most recently PIAAC (OECD, 2016a) exhibit strong relationships among numeracy and literacy proficiency, employment and earnings and other positive life outcomes. Numeracy skills decline during periods of unemployment, perhaps because some numeracy skills are used only at work rather than being reinforced through practice in everyday life (Bynner & Parsons, 1998).

3. An effective measure is needed to capture learners' progress over the relatively short time periods typical of literacy and numeracy programmes

The LSAL project in the United States found no relationship between change in proficiency and program participation “over the relatively short time intervals typical of program participation and of program accountability and improvement cycles” (Reder, 2011, p. 4). Small reported differences may be recorded in pre- and post-program tests but such proficiency gains can also be made by non-participants (Reder, 2008). However, LSAL found

that adult numeracy and literacy programs do “have demonstrable impact on measures of literacy and numeracy practices” over relatively short time-periods (Reder, 2012, p. 5). Similarly, analysis of New Zealand's Assessment Tool data shows little correlation between time on-program and proficiency gain in the short term (Lane, 2013a, 2013b, 2014). A practice measure would fill this information gap.

4. A practices measure could encompass numeracy and literacy practices occurring as part of adults' engagement with digital technologies.

There is growing recognition of the importance of the ability to use technology to solve problems and accomplish complex tasks, what PIAAC terms “Problem-Solving in Technology-Rich Environments” (PS-TRE) (OECD, 2016b). Numeracy and literacy are integral to PS-TRE and digital skills more generally and engagement with ubiquitous digital technology is a feature of many adults' practices, for example, to access products and services online. Potential benefits of improving adults' digital skills include productivity gains and facilitating fuller participation in society by marginalised groups (Bunker, 2010) and learning with and through technology engages and retains learners (Davis et al., 2010; Thomas & Ward, 2010). A recent UK report highlights the need to increase the focus on “digital literacy” skills and for these to be seen as complementary to numeracy and literacy skills (House of Lords Select Committee on Digital Skills, 2015). A practices measure could encompass numeracy and literacy practices naturally, as part of adults' engagement with digital technologies.

5. A literacy and numeracy practices measure is intrinsically sensitive to learner diversity

Because a practices measure focuses on what

adults do, it necessarily encompasses diverse learners and the diverse contexts in which numeracy and literacy are practiced. It should therefore be sensitive to cultural and linguistic diversity and differentiated power relations (Perry, 2012). It should also be sensitive to learning difference, since conditions such as dyslexia and dyscalculia may directly affect adults' engagement in numeracy and literacy practices (DfES, 2006).

In summary, we argue that a measure of numeracy and literacy practices would give a fuller picture of the capabilities of diverse adult learners, complementing proficiency data and attuned to the exigencies of learning programs. Once practices are measured their importance is likely to be recognized by tutors and an increased focus on practices in learning programs is likely to lead to improved outcomes for learners in terms of increased numeracy and literacy proficiency and future life benefits.

Is a Measure of Adults' Numeracy and Literacy Practices Already Available for Use with Adult Learners?

We reviewed a range of measures incorporating numeracy and literacy practices from around the world, including those developed for research and survey purposes such as UPskill in Canada (Gyarmati et al., 2014), LSAL in the United States (Reder, 2012) and PIAAC (international) (OECD, 2016b), and for pedagogical and/or career-related purposes, such as Mapping the Learning Journey (Republic of Ireland) (Merrifield & McSkeane, 2005), the Essential Skills Profiles (Canada), the Australian Core Skills Framework (ACSF) and the Occupational Information Network (O*NET) database (U.S.A.). We found that extant measures vary widely, reflecting differences in purpose, scope, context and target audience. A full review of these measures is beyond the scope of this paper; in this section we synthesize our findings and

outline some features of selected measures.

In the research context, various methods have been used to gather data on adults' numeracy practices. For example, Street, Baker, and Tomlin (2005) investigated the meanings and uses of numeracy in school, home and community contexts, using ethnographic-style approaches, including formal and informal interviews and observations. Brown, Yasukawa, and Black (2014) interviewed and observed production workers in three manufacturing companies using an ethnographic approach to understand the complex range of vocational knowledge and social skills that may go unrecognised by policy makers, lobbyists and managers, and even by the workers themselves.

As we have noted above, numeracy may be invisible to those engaged in it and some numeracy activities are not observable. Noss, Hoyles, and Pozzi (2002) addressed this problem in their research on nurses' conceptions of the intensive quantity of drug concentration by devising simulations of "breakdown episodes" in which the nurses' routines were disrupted. They then developed a task-simulation interview schedule to examine the degree of situatedness of the nurses' knowledge and reasoning and to explore the relationship between context and knowledge by manipulating the mathematical relationships in the breakdown episode in ways that varied the discursive distance between the simulation and nursing practice. They found that nurses' conceptions were abstracted from their professional practice but also limited and shaped by their practice.

International surveys have also explored adults' numeracy and literacy practices. For example, Earle (2011) categorizes types of work practices involving numeracy and/or literacy in his analysis of the OECD's Adult Literacy and Lifeskills (ALL) survey as: financial literacy and numeracy (working with invoices and

prices); intensive literacy (reading and writing letters, emails, reports and manuals); and practical literacy and numeracy (reading diagrams and directions, writing directions, measuring and estimating size and weight, and using numbers to keep track of things).

PIAAC is the most comprehensive international survey of adult skills to date and assesses both cognitive skills and practices in the domains covered (OECD, 2016a). According to William Thorn (2014), OECD's PIAAC Manager, these domains were chosen for reasons of efficiency and policy relevance because they are generic, i.e., highly transportable and relevant to a wide range of contexts and situations. In PIAAC cognitive proficiency is scaled through 500 points divided into six levels for numeracy and literacy. PIAAC also provides information on respondents' use of skills at work and in everyday life, their education, linguistic and social backgrounds, participation in adult education and training programs and in the labor market, and other aspects of their well-being. The frequency and types of practices associated with PIAAC domains are targeted in the Background Questionnaire (OECD, 2010) using multiple items applicable to activities in and out of work (OECD, 2016b). Frequency is measured against five categories: never; less than once a month; less than once a week; at least once a week; and every day. The OECD allows access to the anonymized PIAAC dataset with associated tools, providing an opportunity for researchers to explore relationships between practice and cognitive assessments in the PIAAC domains at scale and for specific population groups.

Meanwhile, in the pedagogical/training context, in Canada, the Essential Skills Profiles associated with UPskill measure frequency of use on a six-point scale from "never" to "every day" for nine essential skills used in the workplace, at the level of difficulty required to perform specified jobs successfully. The

essential skills are: reading; document use; writing; numeracy; oral communication; thinking; digital technology; working with others; and continuous learning. Each essential skill contains a list of essential skills-related example tasks, with complexity ratings from Level 1 (basic) to Level 5 (advanced) that vary based on the requirements of the workplace. Essential Skill Function Overviews describe the purpose and/or use of each essential skill (except for Thinking) (ESDC, 2014). The Essential Skills Profiles can be used directly with individuals and can also help build research, standards and curriculum.

The Australian Core Skills Framework (ACSF) describes the core skills of learning, reading, writing, oral communications and numeracy in a five-level framework built on a range of theoretical perspectives, one of which is "a socio-linguistic and socio-constructivist view of core skills as complex social practices embedded in context, and influenced by purpose, audience and contextualised expectations and conventions" (Commonwealth of Australia, 2012, p. 4). The ACSF can be used as a diagnostic tool to assess individuals' literacy and numeracy skills and also as a tool to inform curriculum development and for mapping learning programmes and workplace skill requirements. In addition to skills/knowledge levels it also outlines examples of activities that individuals are able to engage in at each of the five levels. ACSF thus covers both complexity and frequency of practice.

The Essential Skills Profiles and ACSF are unusual in that they include a measure of complexity of numeracy and/or literacy practices; most of the measures we reviewed cover frequency but not complexity. Also, the frequency scales we encountered do not capture intensity of practice. For example, someone working on costings all day and someone else doing so for ten minutes a day would both be reported as doing so 'every day'. We believe frequency,

complexity and intensity of numeracy and literacy practices are all important and should be measured if possible in order to reflect the nature and extent of adults' numeracy and literacy practices.

In summary, our review of existing measures did not reveal a measure that we felt could be taken "off the shelf" for use in the New Zealand context.

Concluding Remarks

So, here is the quandary. Measuring proficiency in numeracy and literacy is relatively straightforward through traditional tests. However, there is likely to be little if any improvement in skill levels from short-term programs (Reder, 2009; Waite et al., 2014). By contrast, practices are where learners are likely to show improvements in both the short and longer-term and engagement in numeracy and literacy practices leads to later proficiency gains.

It is for these reasons that Reder (2013) argues that measures of engagement with literacy and numeracy practices would be a better way of showing continuous improvement during and after engagement with a learning programme. He does not suggest that proficiency measures be dropped, and nor do we, rather that practice measures be developed to complement them.

Our scoping study suggests that a range of matters will need to be considered in further work to develop a measure of adults' numeracy and literacy practices that is valid, reliable, culturally and ethically sound, cost-effective and practicable for use in busy classrooms and workplaces.

In a later ethnographic study we propose to explore methodological issues stemming from our characterization of numeracy and literacy practice, including identifying a methodological framework and unit of analysis and considering whether the LNS distinction between literacy events and literacy

practices could work for numeracy.

Frequency, complexity and intensity of practice will all be considered in our proposed future research and development, as will the possibility of adopting or adapting an existing measure for use in New Zealand. Meanwhile, the importance of assessment in relation to a structured range of complexity of demand is highlighted in research on numeracy for nursing (Coben & Weeks, 2014). Intensity of practice may also emerge as a significant factor in our proposed ethnographic study.

Ethical considerations will be important because of the need to balance the measurement of numeracy and literacy practices with respect for adult learners' privacy. For example, numeracy and literacy feature in adults' engagement in potentially sensitive issues concerning health, personal relationships and money. We envisage that a proposed practices measure would be guided by an ethical framework.

The relationship between a practices measure and numeracy and literacy proficiency, as codified in the New Zealand adult numeracy and literacy infrastructure, will also need to be considered. This is challenging since we know from LSAL (Reder, 2012) that practices and proficiencies are not neatly aligned. We shall also consider how the results of a measure of adults' numeracy and literacy practices might be used expansively and creatively rather than reductively by education and training providers, government and funding bodies, employers and adult learners themselves to support improved learner outcomes (Coben & McCartney, 2016). For such a measure to gain traction it will be important that it is not too onerous for use in busy learning environments.

In summary, it is clear from the research reviewed here that there is a connection between numeracy and literacy practices, attendance in learning programs and learner outcomes. We suggest that knowing the

learner; knowing the demands; and knowing what to do (National Centre of Literacy & Numeracy for Adults, 2011) would be supported by a measure of adults' numeracy and literacy practices. Developing a richer and "technically more sophisticated" measurement methodology in Schuller's (2001) and Reder's (2016) terms, that would acknowledge and validate adult learners' practice gains, inform teaching geared to their circumstances, needs and interests and complement existing proficiency measures, will be a challenging but worthwhile task. ❖

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