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Literate, Numerate, and Discriminate – Realigning 21st Century Skills

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Abstract: Discrimination can be said to take place during early childhood when the difference between safety and danger are detected even though notions of real and imaginary may still be blurred. Importantly, the versatility of this construct reaches further into lifelong learning and is used in this paper as a means of distilling a range of competencies that are invoked by terms such as information literacy, digital literacy, media literacy, e-literacy, ethical responsibility, global citizenship, and the 'getting of wisdom'. Following a meta-analysis of the various ways in which 21st century skills are elucidated we propose a conceptual re-alignment of the foundation skills of education to include being *discriminate* (discerning) alongside being *literate* and *numerate*. Motivation for doing so arises from two sources: (1) a perceived privileging of literacy and numeracy – particularly in the context of high-stakes testing; and, (2) the converse of this situation in which literacy and numeracy appear to have a diminished presence within the '21st century skills' agenda. A gap between these agendas becomes more prominent when considering that our interactions with the world are increasingly configured by increasing production and consumption of data from an increasing diversity of sources.

Keywords: literacy, numeracy, discernment, data literacy, skills, competence, wisdom

1. Introduction

From an adult learning perspective "(t)he relationship between people's lives and their learning is complex" (Barton, et al., 2007, p.1). It is no less complex for infants and school-age children – and is arguably more so in a turbulent world of economic uncertainty amidst the ever-present immediacy of political, ideological, and religious conflict. Additionally, as emphasised by Castells and Himanen (2014), the global era we now live in is profoundly different from earlier times: "a historical period characterized by the technological revolution in information and communication, the rise of the networking form of social organization, and the global interdependence of economies and societies" (Castells & Himanen, 2014, p.1). Making sense of this world in ways that enable us to engage and contribute to society requires developing appropriate skills and sensibilities. Are literacy and numeracy adequate foundations in this changed context? For Misson and Mason (1997):

> Literacy and education are so thoroughly bound up with each other that a change in literacy practices such as the digital revolution has brought will inevitably have a profound impact on education, just as the changes in education brought about by the new learning technologies will inevitably have an impact on literacy both in its uses across the curriculum and in the teaching of literacy itself (Misson & Mason, 1997, p. 129).

While literacy and numeracy are now globally regarded as prominent foundation skills, these skills are insufficient in terms of developing the whole person, and in contexts that are increasingly rich in inter-cultural and technological connections. For many children worldwide learning how to read, write, and count are now increasingly enabled and mediated by technology. This technology also connects and embeds us within networks of information and communication that are increasingly a catalyst for the propagation of data – data that can then be manipulated for a huge variety of purposes, from providing feedback to instructors and learners in the form of 'learning analytics', informing us how many Facebook 'likes' we have to a post, enabling new forms of business intelligence, to serving the purposes of surveillance. Thus:

> "To thrive in a rapidly evolving, technology-mediated world, students must not only possess strong skills in areas such as language arts, mathematics and science, but they must also be adept at skills such as critical thinking, problem-solving, persistence, collaboration and curiosity" (World Economic Forum, 2016, p. 1).

Such commentary is now commonplace within the literature focused on *21st Century Skills*, although the conceptions and points of emphasis associated with this discourse vary considerably (Voogt, Erstad, Dede, & Mishra, 2013; Griffin, McGaw, & Care, 2012). A simple Google search for images associated with these frameworks reveals an incredible variation, placing emphasis in varying degrees upon competencies that include communication, collaboration, creativity, critical thinking, digital literacy, and global citizenship – but rarely, literacy and numeracy. The recent findings from the World Economic Forum (WEF) are summarized in the form of a compelling graphic in which *21st Century Skills* are presented as three interrelated groups of skills: 'foundational literacies', 'competencies', and 'character qualities' (p. 3). This framework attempts to connect, or re-establish, literacy and numeracy as pivotal foundations of education *within* the evolving competency requirements of the 21st century. As such, it represents a major step forward in this discourse.

For us, however, the WEF framework also reveals significant gaps. An example is that *data literacy* is not listed, let alone addressed. Moreover, while the report acknowledges "the greater variety, volume and velocity of data" it does not deal with how global citizens are interacting with it. This anomaly seems stark when considering the discourse on learning analytics and big data in which 'millions of datapoints' are now identified as potential sources of evidence for learning (Cope & Kalantzis, 2014, p. 221). Thus, an appropriate response to such developments would seem to be that "increasing focus on education as an evidence-based practice requires that educators can effectively use data to inform their practice" (Gummer & Mandinach, 2015, p. 1).

1.1 Literacy

Literacy has become a term with high utility in recent times, such as when used when referring to *information literacy*, *media literacy*, or *computer literacy*. But as Barton and Hamilton (2000) point out: "within a given culture, there are different literacies associated with different domains of life" (p.11). In its most instrumental form literacy is reduced to reading and writing, as reflected in Australia's annual National Assessment Program - Literacy and Numeracy (NAPLAN). This is despite UNESCO reflecting over a decade ago:

> "Literacy is the ability to identify, understand, interpret, create, communicate and compute, using printed and written materials associated with varying contexts. Literacy involves a continuum of learning in enabling individuals to achieve their goals, to develop their knowledge and potential, and to participate fully in their community and wider society." This proposed definition attempts to encompass several different dimensions of literacy. Yet because even this plural notion of literacy remains centred on the life of the individual person, more reflection should be given to incorporating into it the various circumstances in which individual learners live their lives. An attendant challenge has to do with accurately monitoring and assessing the multiple forms of literacy (UNESCO, 2004, p. 13).

1.1.1 The 'new literacies'

The digital revolution can be seen as a powerful agent of change in terms of the ways in which *literacy* has been appropriated as a qualifying term to indicate competence or knowledge of some domain of practice. There are numerous examples but the most prominent have been *information literacy, computer literacy, media literacy, network literacy*, and *digital literacy*. While there might be implied differences in meaning between these terms it is clear that the semantics associated with literacy prior to the digital revolution were more concerned with the basics of reading, writing, and communicating. Thus, when we consider that digital technologies have also been commonly referred to as information and communication technologies (ICT), it would seem there is a natural progression for literacy to be qualified by terms such as *information*, *computer*, *media*, *network*, and *digital*.

In proposing a taxonomy of literacies Stordy (2015) provides a useful framework for understanding the evolution of this term in which the notion of *new literacies* first emerges. As seemingly comprehensive as it is, however, it does not contain any reference to *data literacy*, a term

we identify as a key concept because it has made us wonder where it fits best given that numerical data is something that really belongs to an updated notion of numeracy (Athanases, Bennett, & Wahleithner, 2013; Deahl, 2014; Gummer & Mandinach, 2015; Koltay, 2015).

1.2 Numeracy

One of the impacts of the rapid development of digital technologies is upon our micro habits. Thus, the advent of wearables such as Apple and Samsung watches, virtual reality headgear etc., the boundary between our natural human cognition and an increasingly extended domain that technology enables has begun to blur. Exploring such innovations can be exciting but also bring new challenges in terms of processing, authenticating, securing, and discriminating data.

What has this got to do with numeracy? In this rapidly evolving information age, numbers mostly come in form of figures, graphs and statistics. We see them routinely in medical reports, financial advice, government policies, and in the daily news media which are all filled with charts and data. The presentation of data in this quantitative form has a consequence that the soundness of the decisions we now make on daily basis is increasingly dependent on having an understanding of how the data might have been gathered and analysed, not just presented. Developing such skills could be understood in terms of both numeracy and *data literacy*.

While the semantics implicit in *data literacy* can be readily inferred or understood (Vahey, Yarnall, Patton, Zalles, & Swan, 2006) and as common within STEM education (Qin, J., & D'Ignazio, 2010) we think the numeracy aspect is somehow masked or rendered subservient. Moreover, as we discuss later, the capacity to discern the soundness of data demands a critical capacity to discriminate.

1.2.1 Numeracy and modern education

When the term *numeracy* was introduced into educational curriculums in Britain in the mid to late twentieth century it was presented as equivalent to *quantitative literacy*, a term which was simultaneously employed as its synonym. The expectation was that by having this core skill (on par with literacy) the ordinary citizens would have sufficient skills with handling numbers to become quantitatively literate (Steen, 1999).

For the past few decades much research has been done to explain and bridge the gap between the data skills and numeracy of the public (Steen, 2001; Sullivan, 2011). However, there remains confusion with regards to the right balance between numeracy for community life and its relation to core mathematical processes. The Program for International Student Assessment (PISA) uses the term *mathematical literacy* to describe:

> […] an individual's capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena. (OECD, 2013, p. 25)

Mathematics is considered by educators as a system composed of multiple, interconnected and interdependent concepts and structures which students must apply beyond the classrooms. There is, however, no clear mandate on what essential elements in the basic education of mathematics this constitutes. While all K-12 educational curriculums consider algebra, probability and geometry as a core combination of skills, they will inevitably fall short of producing the numerically abled citizen without concomitant foregrounding of discernment of the selections, uses and consequences of these skills.

1.2.2 Data Literacy

Could one of the core functions of education in our global era be to raise student awareness of data, statistics and related implications, particularly the data we encounter in everyday life? Such a proposition may be implicit in many curriculums but it is not always explicit. Even within the *21st Century Skills* discourse such a notion seems to be inferred as an aspect of *digital literacy* or *ICT literacy* when combined with skills such as *critical thinking* and *problem solving* (Griffin, McGaw, & Care, 2012). An alternative is to define *data literacy* as a skill in itself. But while adopting such a term within this discourse makes sense, such a term also needs to be adequately explained in context. It

could just describe the safe handling and manipulation of a variety of data and information on a daily basis, and from a variety of digital devices. For us, more important is the discernment and discrimination required to make sound decisions. This would not be possible unless we teach students to understand how to identify questions, collect evidence (as data) and discover and apply tools to interpret, communicate and exchange results (Rumsey, 2002).

Wells (2008; 2015) highlights the question '*what's the point, sir*!' It is precisely the point of mathematics that students learn to actively think and ask this question when dealing with data in order to separate the truth from vagueness that data, formulas, interpretation and context bring along, to separate real from imaginary, argument from rhetoric, fact from fiction and plausible from certain.

The main aim of basic mathematics education is to develop mathematical thinking. Being *numerate*, however, does not encapsulate the core of mathematical thinking. In contemporary global settings the development of mathematical thinking also implies reasoning and processing skills that involve precision while also enhancing intuition and problem solving abilities. Such skills underscore the rationale for the advocacy of STEM education in our increasingly data-driven and evidence-based requirements of social and economic advancement.

Innovation can also be seen as emerging from the ability to discriminate. Prime numbers versus composite numbers, odd versus even numbers, normal distribution versus skewed distribution, maximum versus minimum, certainty versus uncertainty, and so on. Discrimination is an ability to find the odd one out – while looking for patterns, asymmetry stands out. Recognizing and discriminating digital data when each individual action gives rise to another set of data is a skill that is missing from our educational frameworks – where numerate and literate are the main focus.

In our view, *data literacy* can be subsumed within a core skill of being able to *discriminate*. Such a conception is more encompassing than the operational aspects of being literate and numerate. It is not necessarily separate from literacy and numeracy but another lens through which to read the world. In other words, an essential ability needed to quantify, qualify, discern, and predict. Thus, researchers have identified data literacy as a core competency within library science and STEM education. To date, however, it is significant that a key concern is with the ethical use of data when sharing and reusing it (Koltay, 2013; Zilinski, et al, 2014). A typical example is well summarized by Calzada Prado & Marzal (2013) where data literacy is described as the ability that "enables individuals to access, interpret, critically assess, manage, handle and ethically use data" (pp. 123-124). Combining, discriminating and aggregating different sources of data also assists in posing new questions and seeing new angles. Teaching data literacy, then, could therefore be classified into five aspects:

- *Reading the data* – understanding the need for data to be collected; recognizing more than one way to collect and present data; literate with the basic concepts; numerate in understanding formulas, graphs, charts and tables, etc.
- *Questioning the data* – critically appraising the provenance of data; checking on who, how, why, and when the data was collected; examining sample size, census, and survey integrity; questioning the methodology; assessing data quality; and identifying potential issues.
- *Reading between the data* – understanding of various factors that may have an impact on the data, how a bias might have been or could have been introduced; questioning what is not stated; sample selection, patterns, errors and outliers.
- *Reading beyond the data* – understanding methodological issues such as sampling technique, survey design, noise, context, significance, randomness, independence, and metadata; distinguishing between correlation and causation, understanding how a third variable may explain a relationship between the two others;
- *Using data* – predicting and generalizing from available datasets; understanding trends, drawing inferences; appreciating public and private use, ethical actions and consequences; drawing inferences and understanding the difference between wise and irresponsible use.

We see the ability to make ethical decisions and employ analytical and questioning skills in diverse contexts as paramount. Thus, the ability to ask the question '*what's the point?*' is not only a fundamental act of sense-making but also being *discriminate* in order to understand better. For example, in the context of both mathematics education and data literacy:

> Regardless of where a person is involved in the chain of statistical information, there will be a need for a basic understanding of the concepts and language, a level of reasoning (the abilities

to question, compare, and explain) and a level of statistical thinking (applying the ideas to new problems and identifying questions of your own) (Rumsey, 2002).

Applications of mathematical skills are ubiquitous, be it geometry in art and architecture, calculus and measurement in science, syllogism, logic and reasoning in language and communication, ratios and patterns in music composition, matrices in data representation and ranking, or games and networking. All these contexts require us to reason, process and distinguish useful versus useless, and to collect evidence and interpret results. And all these skills require moving beyond mere ordinary number operations and applying computational algorithms. Our reasoning skills require us to discriminate and compare the data we might access, with the answers established by our internal thinking mechanism before we process it. Under discriminate we distinguish and connect; through this we understand the difference between the background data from the main data and be aware of the relationships that may or may not exists.

2. Conclusion

Public policy associated with education is typically expressed at the jurisdictional and institutional levels. As a consequence of recognising global trends, it is increasingly common for reports from non-governmental organisations and private consortia to gain prominence in setting agendas – and therefore, in influencing policies. The *New Vision for Education* from the World Economic Forum in 2016 and the *Millennium Development Goals* articulated by UNESCO in 2000 followed by the *Sustainable Development Goals* in 2015 are all cases in point.

The 21st Century is already awash with data. Individuals, including children, are both bombarded with data, and are themselves data, and amid the multiple literacies that are appropriated and apportioned to various tasks and agendas it can be easy to lose sight of the roles that literacy and numeracy continue to have. While such foundation as 'literacies' (WEF, 2016) might describe what an individual needs to be equipped for lifelong learning and live a better life there is a third foundation upon which most of the new 'literacies' depend. That requires discernment and discrimination – even wisdom.

Within the 21st Century Skills framework developed by WEF (2016) the role of critical thinking is potentially at the fulcrum. That is, insightful and discriminating thinking that cultivates personal and social wisdom, as opposed to that which is cynical and dismissive (Wright, 2003). It is also instructive to consider this framework in terms of its sub-heading: *Fostering Social and Emotional Learning through Technology*. This kind of thinking is not new of course. It has its roots deep in pedagogical thought: *phronesis*, Aristotle's Practical Wisdom.

Such discriminate thinking is not a solely rational cognitive function. Discrimination also functions in affective and kinesthetic ways. Arguably, discrimination also has a dark side when manifest as racism or bigotry of any kind. But this is our point – to be discriminate requires the identification of at least two distinctions: right versus wrong, safety versus danger, abstract versus concrete, odd versus even, rational versus irrational, etc. In many ways it both requires and extends beyond critical thinking. Creative competency is also required to imagine relationships between what might be actual and what might be possible. To be discriminate requires pause to envision different directions, have empathy, perceive connections, and to imagine real consequences. Choices are made knowingly, emotion and imagination are also at play – and quite different from spontaneous reactions to preferences. Importantly, this can be taught (Garrison, 2010).

In drawing this discussion to a close we are acutely aware that our own investigation into this topic represents initial findings as a work-in-progress. The two key findings to date are as follows:

(1) While there are numerous conceptualisations of what 21st century teaching and learning entails, the alignment between the foundations of high stakes literacy and numeracy testing on the one hand and the skills and competencies expressed in various formulations of 21st century skills appears to be only beginning to take place; and,

(2) Missing from public policy associated with the foundations of an appropriate education for the 21st century is any detailed discussion of the role of discrimination. We see such an ability as an essential dimension for the development of an informed, wise, and just society and at least as important as the other so-called 21st century skills. In short, discrimination needs to be expressed in terms more robustly than as a 'character quality' (WEF, 2016).

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