On the complex geometry of individuality and growth: Cook’s 1914 “Curves of Life” and reading measurement

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Abstract. Growth in reading ability varies across individuals in terms of starting points, velocities, and decelerations. Reading assessments vary in the texts they include, the questions asked about those texts, and in the way responses are scored. Complex conceptual and operational challenges must be addressed if we are to coherently assess reading ability, so that learning outcomes are comparable within students over time, across classrooms, and across formative, interim, and accountability assessments. A philosophical and historical context in which to situate the problems emerges via analogies from scientific, aesthetic, and democratic values. In a work now over 100 years old, Cook’s study of the geometry of proportions in art, architecture, and nature focuses more on individual variation than on average general patterns. Cook anticipates the point made by Kuhn and Rasch that the goal of research is the discovery of anomalies—not the discovery of scientific laws. Bluecher extends Cook’s points by drawing an analogy between the beauty of individual variations in the Parthenon’s pillars and the democratic resilience of unique citizen soldiers in Pericles’ Athenian army. Lessons for how to approach reading measurement follow from the beauty and strength of stochastically integrated variations and uniformities in architectural, natural, and democratic principles.

1. Growth in reading ability

Over the last several years in the U.S., new standards for reading education, termed the Common Core State Standards (CCSS), have been criticized for tendencies to focus too narrowly on quantitative representations of text complexity. This focus is said to come at the expense of broader qualitative aspects of what makes reading easy or difficult. Many fear that inordinate concern with raising the complexity of text may displace legitimate concerns with other problems affecting education outcomes [1,2]. Debates have been contentious for the early grades, as these set the stage for later growth but lack clear guidelines for evaluating text complexity [3]. Suggestions for such guidelines [4] are augmented by Williamson [5], who notes individual differences in reading growth, marked by variation in starting points, rates of change, and decelerations as learning reaches the diminishing returns of higher levels.

Williamson [5] also points out that few individuals grow in reading ability along the smooth path defined by the average trajectory. Any given end point might be achieved by one student who started from a higher level, showed slow, steady growth, and barely decelerated through middle and high

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school. Another student starting from a lower level of reading ability might progress very rapidly, with a moderate amount of deceleration, and could reach the same twelfth-grade reading ability as the first student, but via different individual growth curve.

Addressing these key features of growth (status, velocity, and deceleration) in educational policy and pedagogy could lead to new approaches to improving reading outcomes [6]. Initial status might be elevated on broad scales via early-intervention reading programs, velocity could be increased by means of intensive practice, and deceleration might be counter-acted by creative approaches to summer school.

These practical suggestions fit well, perhaps unexpectedly, in a larger context of aesthetic, scientific, and democratic values. This expanded perspective is opened by Theodore Cook’s 1914 book, The Curves of Life [7]. In it, Cook anticipates a number of later developments in the philosophy of science, measurement modelling, and political philosophy that hinge in large part on understanding the relation of individual differences to larger population-based proportions and patterns. Cook anticipates fractal and chaotic concepts concerning the role irreducible randomness plays even in arithmetic and Newtonian physics. Cook’s perspective on the roles of deviations and exceptions to growth in nature and its adoption in art and architecture is related to Kuhn’s [8] and Rasch’s [9] emphases on the role of anomalies in measurement, and to Bluecher’s [10] analogy between the uniqueness of the Parthenon’s pillars and the individuality of Periclean citizen-soldiers. Improving growth in reading might find an enlarged base of support in a context foregrounding these aesthetic, scientific, and democratic values.

2. Aesthetics
Cook [7, p. 325] points out that "The 'straight lines' of the Parthenon…are in reality subtle curves." Details of the many delicate irregularities in the Parthenon (see figure 1) include the facts that:

No two neighbouring capitals correspond in size, diameters of columns are unequal, inter-columnar spaces are irregular, the metope spaces are of varying width, none of the apparently vertical lines are true perpendiculars, the columns all lean towards the centre of the building, as do the side walls, the antae at the angles lean forward, the architrave and frieze lean backward, the main horizontal lines of construction are in curves which rise in vertical planes to the centre of each side, and these curves do not form parallels [7, pp. 328-329].

These variations from perfection in the Parthenon tend to be explained using one of three approaches: the compensation theory, the exaggeration theory, and the tension theory [11, pp. 75-76]. Compensation suggests that the deviations are built into the structure in order to correct the deficiencies of perception, to make things look more proportionate than they would look if they were actually as proportionate as possible. The exaggeration theory takes the view that the intention was to make the building look more impressive or larger than it really was. The tension theory suggests that the deviations combine into wholes greater than the sum of the parts, and so give the structure a vitality it would otherwise lack.

Figure 1. Exaggerated view of unique Parthenon pillars [11]
Pollitt [11, p. 78] suggests that the tension theory “seems to reflect most naturally the intellectual experience of the age,” since the measured variations are intentional deviations from ‘regularity’ for the purpose of creating a tension in the mind of the viewer between what he expects to see and what he actually does see. The mind looks for a regular geometric paradigm of a temple with true horizontals, right angles etc., but the eye sees a complex aggregate of curves and variant dimensions. As a result, the mind struggles to reconcile what it knows with what the eye sees, and from this struggle arises a tension and fascination which make the structure seem vibrant, alive, and continually interesting [11, p. 76].

Cook [7] similarly asserts that "...phenomena of life and beauty are always accompanied by deviations from any simple mathematical expression we can at present formulate" (p. 434).

3. Science

The task of science was long considered discovery of scientific laws, and scientific method was a set of routinely repeatable steps in a process sure to lead to new knowledge. But questions about the roles of language and technology in theory development and data acquisition led to new ideas about scientific change. One result was the realization, as Kuhn [8, p. 219] put it, that the road from scientific law to scientific measurement can rarely be travelled in the reverse direction. To discover quantitative regularity one must normally know what regularity one is seeking and one's instruments must be designed accordingly.

In this context, theoretical expectations embodied in measuring instruments come to the fore as the media in which facts become either salient or meaningless. In Kuhn’s [8, pp. 205-206] words, "To the extent that measurement and quantitative technique play an especially significant role in scientific discovery, they do so precisely because, by displaying significant anomaly, they tell scientists when and where to look for a new qualitative phenomenon."

Like Kuhn, Cook [7] makes repeated statements concerning the same point, for instance, that "Clearly it will be unprofitable to emphasize the value of variations unless we also suggest some standard by which those variations can be measured" (p. 400; also see pp. 431, 434-435). Cook [7, p. 431] further maintains the parallel with Kuhn, remarking on the anomalies in the orbit of Uranus that led to the discovery of Neptune, a parallel also noted in theory-informed Rasch measurement [13,14].

Rasch [10, p. 124], writing before Kuhn, similarly noted that "Once a law has been established within a certain field then the law itself may serve as a tool for deciding whether or not added stimuli and/or objects belong to the original group." Rasch [15, p. 1254] speaks of modelling and instruments as delimiting the field of validity; i.e., finding those agents and objects with the properties that belong within the specified frame of reference. A basic goal of measurement then ought to be to support the identification of anomalous and unique patterns, and the deployment of methods for translating those patterns into opportunities for individual, community, or organizational growth.

4. Democracy

An ethical and political theme emerges here in the identification of anomalies. A common but mistaken assumption is that measurement excludes test or survey items, and examinees or respondents, associated with inconsistently ordered responses. An alternative approach allows the exceptional observations to inform the interpretation and application of the measure [16]. Tools facilitating use of all data, qualitative and quantitative, fitting the measurement model and not fitting it, are available. The KidMap [17], for instance, is a graphical illustration of correct and incorrect test answers, or agreeable and disagreeable survey responses. Strong theoretical reasons and empirical support for the overall validity of the measurement process and results [18,19] sets the stage for integrating local departures from general expectations [20].

Individual variability is less a threat to objectivity than an opportunity for learning. Extending Cook’s point, Wonk [21], recounting Bluecher [10], notes that Greek temple pillars are unique, curved, each one slightly different. They are harmonized in a united effort. They are a democracy. Whereas, the temples of the older, Eastern empires are supported by columns that are
simply straight sticks, interchangeable. The phalanx of individual citizens was stronger than the massed army of slaves [which enabled 9,000 Greek citizen soldiers to defeat 50,000 Persian mercenaries and slaves at the Battle of Marathon in the fifth century BCE].

In that same spirit, should we not today expect to incorporate universal standards for reading education outcomes into the new electronic universe of digital learning environments? Could doing so aid in extending universal human rights to literacy? In the same way that each pillar in the Parthenon is unique but bears its full share of the roof’s weight, each citizen in a democracy is a distinct individual but shares full responsibility for the governance of the community. So, too, each reading student should be recognizable for her or his separate value while still having access to valid information on where he or she stands relative to everyone else and relative to basic expectations for success as an adult.

5. Conclusion

Cook [7] emphasizes that:

...there are many more interesting instances of deliberate and delicate divergence from mathematical accuracy, and it is this divergence which gives the Parthenon its living beauty. For the essential principle of life and growth is constant variation from the rigid type.

What might we take from Cook’s sense of wonder and awe before architectural and natural expressions of unique individuality that nonetheless conform to universal patterns? How might divergences from mathematical perfection be seen to bring out the living beauty of growth in reading? Can constant variation from the rigid type in the varying starting points, velocities, and decelerations of growth in reading be understood as an expression of the essential principle of life and growth? If so, it may have the potential to aid in correcting the larger problems in education potentially glossed over by inordinate focus on matters of increased text complexity [1].

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