Chapter 1
A Language and a Space: Visualizing Learning Online

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ABSTRACT
Visualizations are quickly becoming an integral part of learning analytics for knowledge discovery, sensemaking, and insight. Empowering educators and learners, visualizations make data graphically accessible through a range of perceptual modes. As the embodiment of learners’ data, visualizations give them a thing to reflect upon, potentially arriving at insights they may otherwise not have. Visualizations aid educators in behavioral monitoring, formative feedback provision, and strategic intervention. They support learners’ motivation and self-regulation, focusing attention on the behaviors associated with academic success. As a mechanism for joint knowledge work, visualizations are collaboratively used to produce, translate, and facilitate communication around shared learning artifacts. This visualization survey explores disposition, predictive, semantic, discourse, collaborative and social learning analytics tools within a variety of learning spaces. In their entirety, they represent both the historical and the novel, from conceptual designs to empirically validated tools.

INTRODUCTION
Following the Industrial Revolution, schools adopted a regimented learning model focused on routine and rote memorization to meet the labor needs of factories. Fast forward to today and it is knowledge work, rather than labour, that is a key wealth-generating resource (Savage, 1996). As such, information literacy – an intellectual framework for understanding, finding, evaluating, and using information – is a desired competency gaining a foothold in classrooms (Association of College & Research Libraries, 2013). Learning analytics (LA) tools offer a way of presenting data that builds learners’ fluency with information technologies, an important competency in today’s workplace. Though the impetus for the presence of visualizations in the classroom is motivated by a cultural shift to knowledge work, the visualizations within this chapter represent a wide variety of constructs at varying levels of sophistication. A
subset of learning analytics, visual learning analytics tools (VLATs) have been impacted by the increased numbers of online learners, the shift of non-traditional learners to majority status, and the participatory nature of our social media culture.

The appropriation of learning analytics and the visualizations that support them is motivated from the top down – informing administrations of learners’ progress and persistence – and the bottom up, from the individuals directly involved in learning practice. With a focus on informing and empowering educators and learners (Siemens & de Baker, 2012), learning analytics are uniquely poised to inform policy and practice. At the core of empowerment decisions are discussions about who should have access to the learning technologies based on greatest need, benefit, or overall impact. Existing visualizations for educators far outweigh those for learners, likely in part because educators may better leverage their pedagogical expertise, power, and influence in learning spaces. Similarly, most existing interventions address the needs of at risk-learners rather than the general population. As we continue to move away from a Socratic model of education, there is a need to create tools for diverse education models, particularly those that are learner led. Use of the term learner here is meant to include individuals learning outside of the academic environment the term student implies. This includes learners in the workplace, Massively Open Online Courses (MOOCs), and Personalized Learning Environments (PLEs).

Visualization is an effective way to support a deep understanding of complex interactions (Medina & Suthers, 2009; Saltz et al., 2004; Hirschi, 2010). Though there is clear value in ability of visual analytics to amplify, extend, and enhance human cognition, the design and evaluation of VLATs has been almost a by-product of the research in learning analytics. Visualizations are often implemented and tested only for the aspects of usability they contribute to learning analytics tools. This collection of VLATs is part of an effort to position them as the next phase of learning analytics’ maturation, as an entity that will eventually find a space of its own within this nascent field.

**BACKGROUND**

With little exception, when it comes to taking in information, vision ultimately trumps our other senses. The tight coupling between visual perception and cognition is even evident in our language, in the relationship between understanding and seeing (Ware, 2005). Visualization is both a mental process and a tool for knowledge discovery, sensemaking, and insight. Visualizations as tools transform perception by amplifying or reducing the data they represent. An art and a science, visualization is informed by the nuances of graphical design. Lines, points, curves, position, and color – these attributes are the words of graphical language. Information visualization uses these words to abstract and represent all kinds of data, from observations in the natural world to the relationships formed in simulated learning spaces. The ability of visualization tools to transform complex, multi-dimensional data is one of the many benefits of the science. Its ability to inspire creativity and curiosity is an allowance of the art.

Visual representations of learning data must strike a delicate balance between often-divergent goals. Given a messy data set visualization lends structure, making connections and patterns easier to recognize. Through simplification or filtering, visualization can be used to improve the efficiency of data search. At other times, aesthetics and abstraction are best used to communicate ideas about data, while perhaps even evoking emotion in the process. When it is most important to stress the instability of a system, a