How Does This Visualization Say I’m Doing? Handling Uncertainty in Learning Analytics

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Abstract  
In this position paper we discuss differences in the needs of online and blended learning students as they pertain to the aspect of uncertainty in visualizations of learning data. While learners do not necessarily need to know the underlying algorithms of the learning analytics, they must have enough insight in how they are being evaluated to trust the visualizations. The presentation of our case study is followed by recommendations for dealing with uncertainty with learners who are information visualization novices.

Author Keywords  
Visualization design; learning analytics; uncertainty visualization; information visualization; judgments of learning; perceptual reasoning.

ACM Classification Keywords  
H.5.2 User Interfaces: Screen design (e.g., text, graphics, color), User-centered design, Theory and methods; H.1.2 User/Machine Systems: Human factors.

Introduction  
In this position paper we introduce (1) one author’s experience in online and blended teaching contexts as it pertains to differing need for learning analytics (LA),
(2) a recent study performed in our lab as a case study, (3) going forward, how we plan to address visualization design for online learners.

As an instructor in higher education for the past decade I have found great differences between two populations that I serve. While the face-to-face and blended course students are largely traditional, attending college directly after high school, the online learners are most often working adults intent on advancing or changing their careers. Returning to academia after an extended period of time, many learners may carry a diminished sense of their own self-efficacy or ability to learn in an academic setting. While the higher level of autonomy in online courses often speaks to the mature learner, it may also result in higher attrition rates [6].

Whether new to academia or returning to it, learners’ perceptions of academia are often as “a world apart,” for good reason. They are asked to converse and collaborate with individuals with whom they have few if any commonalities, using unfamiliar language, in a manner that is admittedly foreign in relationship to both in-person and email communication. More interactive than an essay and more critical than a casual discussion, these online discussions help learners develop the discipline-specific language to converse by making evidence-based claims, evaluations, and counter-arguments. As the most often utilized online learning tool, discussions are the logical site for evaluating LA visualization designs.

**Learning Analytics**

Social cognitive models of learning are all dependent upon interaction, particularly the provision of feedback,
to evoke higher-level critical thinking [1]. As the discussions evolve learners engage in the recursive self-regulatory process of assessment, adjustment, monitoring, and reflection. LA offer learners a visual means to engage in this process, making learners aware of their message quality, under or over developed discussion topics, standing in relationship to the rest of the class, and their progress toward achieving their academic goals. To understand how learners perceive LA, we must understand how they perform visual interrogations with these tools.

There are limitations in the type, number, and complexity of LA learners can and will attend to. Aside from uncertainty in the LA’s interpretation based on learner’s motivation, familiarity, and confidence in information visualizations, it also lies in the portrayal of discussion contributions, and their ability to demonstrate goal achievement during dynamic learning activities.

Case Study
We gathered qualitative and quantitative data from a total of 8 different discussion activities in 4 blended and 2 online courses. The activities ranged from 7-10 days, and were undertaken in groups of 4-6 learners. Learners (N=239) were randomly assigned to the control or one of two LA groups. Representing individual difference [8], questionnaires on goal orientation [3], numeracy [2, 4, 9], and cognitive reflexivity [5, 11] were also completed.

One of the two visualizations used in the study was a matrix of instructor-provided keywords that indicated three levels of learners’ discussion post quality (see Figure 1A). The top contributor visualization was a leaderboard indicating the top 5 contributors to the discussion, their photo, and the number of posts they had contributed thus far as compared to the individual (Figure 1B).

Results & Discussion
Unexpectedly, participants had significant issues using the visualizations because they did not understand the visualizations or the data within. The matrix confused more participants than the contributor visualization, particularly early on in the discussions. The matrix populated on 5 minutes intervals as learners participated in the discussions.

The lack of “definitive” measurements rather than a high, medium, and low categorization was also confusing. The three thresholds were established based on previous Cognitive Presence instrument research [6]. The underlying algorithm was not shared with learners; the displayed metrics were simplified to indicate high, medium, and low quality. Several learners citing this as a reason for not trusting the visualizations, even though their instructors selected the keywords from the course readings. Another source of frustration was that learners assumed their matrix would update immediately after every post. The top contributor visualization was used more and received slightly higher, though insignificant, ratings. Comments on this visualizations focused on who was depicted – the class rather than individual groups – and the lack of a quality-based contribution ranking.

Online learners more readily gave feedback on their experience with the learning analytics, due likely in part to their greater reliance on them in the discussions than the blended learners. Results on the test of
cognitive reflexivity were low in comparison to other university students, supporting the explanation that learners’ frustrations with the visualizations stemmed from not reading the instructions or tool tips.

**Revisiting Complexity & Uncertainty**

Going forward we consider *increasing* the complexity and uncertainty of the visualizations to aid in their interpretation, and to motivate learners to attend to and reflect upon them. In addition to suggestions by fellow workshop participants, we seek to:

- Increase the explanatory value of the visualizations by indicating the topic evolution and the relationships between users, with respect to time (without explicit categorization).
- Visualize passive or non-participatory behaviors, particularly reading but not responding.
- Increase learners’ confidence in the visualizations.
- Increase level of visual abstraction to encourage learners to spend more time reflecting on their learning.
- Identify visual referents to aid in performance categorization across multiple keywords [7].

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**References**