

“Belonging analytics”: A proposal

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Students' sense of belonging is associated with successful transition into higher education and a range of positive outcomes including enhanced learning, well-being, and demonstrated achievement. The COVID-19 pandemic underscored the importance of belonging as the shift to online learning highlighted the challenges of supporting and monitoring student belonging. Attending to belonging is not simple, however; students' experiences with belonging are complex, dynamic, and contextual. In creating a new agenda connecting the fields of belonging and learning analytics, we propose the idea of “belonging analytics” to address the challenge of supporting and tracking students' belonging. In this paper, we discuss how the understanding of belonging may be enhanced through learning analytics. Advancements in learning analytics, such as digital trace data, narratives, textual data, or a combination, may be harnessed to gain insights into ongoing experience of belonging, and consequently to support belonging. We conclude with a set of open questions to interested researchers and practitioners, to advance the field of belonging analytics.

Keywords: belonging analytics, engagement, higher education, learning analytics, sense of belonging

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Recommended citation: Lim, L.-A., Buckingham Shum, S., Felten, P., & Uno, J. (2023).

“Belonging analytics”: A proposal. *Learning Letters*, 1, Article 4.

<https://doi.org/10.59453/EAXA8005>

“Belonging” in higher education

Belonging is a fundamental human need, and the desire to belong motivates people to act in ways that lead to positive social interactions and meaningful personal relationships (Baumeister & Leary, 1995). Empirical studies demonstrate the link between students' sense of belonging and successful transition into higher education (Araújo et al., 2014; Meehan & Howells, 2019; Tinto, 2003), as well as both academic performance and persistence to graduation (Dewsbury et al., 2022; Fisher et al., 2019; Strayhorn, 2012). Sense of belonging mitigates stress and improves students' mental health and well-being (Allen et al., 2022). It also correlates to post-graduation employment outcomes (Allen et al., 2022; Strayhorn, 2012).

Because belonging is inherently relational, a student's sense of belonging emerges from interactions with others (Kahu & Nelson, 2018). This means that higher education institutions can enable or constrain a student's sense of belonging through their curriculum and programming (Nunn, 2021). Faculty teaching and assessment practices are particularly important for cultivating student belonging (Felten & Lambert, 2020). The recent pandemic highlighted the importance and the challenges of teaching and assessing in support of belonging in online environments (Garrad

& Page, 2022; Lim et al., 2022).

Despite the flood of attention, belonging is a multifaceted concept that is not uniformly defined (Ahn & Davis, 2020; Kahu et al., 2022). In higher education, scholars (e.g., Asher & Weeks, 2013; Strayhorn, 2012) tend to describe two core components of belonging as a sense of:

- being valued by and meaningfully involved with others, and
- personal fit with others.

Empirical research points to distinct dimensions of belonging, including academic belonging as well as social and campus-community belonging (Ahn & Davis, 2020; Kahu et al., 2022). Because belonging is highly contextual, “experiencing belonging in one of these realms does not directly translate to belonging in any other realm” (Nunn, 2021, p. 12). Furthermore, students experience academic belonging at multiple levels – institutional, discipline, or classroom (Kahu 2022; Wilson et al., 2015) – and in different ways over their study trajectory (Kahu et al., 2022).

Recently, scholars have critically questioned the value and utility of using belonging to understand the experiences of students from groups that are historically excluded from or marginalised in higher education (Raaper, 2021). For example, in the United States, students of colour tend to report lower sense of belonging than their White peers (Cole et al., 2020). There is also a call to focus on the importance of students feeling valued (“mattering”) since that is attainable for all students, whereas “fit” requires a student to assimilate to a dominant culture (Cook-Sather et al., 2023). These critical scholars stress the importance of student agency in cultivating their own sense of mattering, and of storytelling and dialogue as means to understand students’ experiences.

To summarise, belonging is a complex and contested construct, yet overwhelming empirical evidence demonstrates that aspects of belonging contribute significantly to student learning, achievement, and thriving. Because higher education staff and institutions can influence students’ sense of belonging, it has become a central facet in higher education reform efforts globally: “everyone is talking about belonging” (Lu, 2023, p. 1).

The challenge of tracking belonging

A student’s dynamic and contextual experience of belonging presents challenges for tracking and responding to student needs in a timely manner. Belonging is typically measured with self-report surveys such as the University Belonging Questionnaire (Slaten et al., 2018). While these capture snapshots of belonging, care must be exercised in their frequency, in order to obtain quality responses. Qualitative approaches, including interviews and focus groups, can elicit richer data about a student’s evolving and situated sense of belonging (Felten & Lambert, 2020; Nunn, 2021), but are difficult to scale. As well, the increased shift to online learning has meant greater challenges in monitoring student belonging due to limited interpersonal interactions that offer opportunities to observe behavioural cues.

We argue that learning analytics (LA) offers the potential to address these challenges, providing novel and dynamic insights into belonging, helping students better understand and develop a sense of agency in their own journeys through higher education, and allowing institutions to be more responsive to students’ evolving experiences and needs. This will require the integration of rich qualitative data with the power of statistically meaningful quantitative data. If it is possible to track valid indicators of students’ sense of belonging longitudinally, at scale, in a timely manner, what we term “Belonging Analytics” could contribute significantly to learning,

well-being, and equity in higher education.

The emerging landscape of Belonging Analytics

Here we present the nascent landscape of Belonging Analytics. Given its complexity, any approaches that seek to quantify and reify “belonging” or “mattering” must do so with great care, otherwise there is a danger of selecting low-level data as “low hanging fruit” (Liu, Rogers, & Pardo, 2015, p. 685) that detract from meaningful insights into students’ belonging. Our proposed framework follows the learning analytics cycle (Clow, 2012), with data generated by students being transformed by analytical agents into metrics for feedback. As an organising framework, Table 1 shows how each of the approaches described next can be located within a two-dimensional matrix defined by the data source (e.g., student self-report, student artifacts, activity data traces); and the analytical agent (interpreting the data by student, educator, or computer), which can be configured to provide diverse forms of data-driven formative feedback to students, or analytics for educators (the cells). While these examples are not exhaustive, they offer possibilities with respect to addressing belonging.

Table 1: A framework for Belonging Analytics: Agents, data, feedback.

Data sources	Analytical Agent		
	Student	Educator	Computer
Student self-report	Participatory Narrative Coding	Conventional human feedback	Dispositional Learning Analytics
Student artifacts	Evaluative judgement Peer feedback	Conventional human feedback	Writing Analytics Discourse Analytics
Activity data traces	Rare for students to analyse log data	Activity-based personalised feedback	Learning Analytics Dashboards Social network analysis

Each approach (cell) in the matrix brings its own strengths and weaknesses, but combined, could in principle provide complementary lenses on belonging, at the student, cohort, or institutional level. The dark blue cells reflect configurations that do not exemplify belonging analytics (no computational agent involved), and the light blue cells indicate the examples introduced next.

Dispositional Learning Analytics

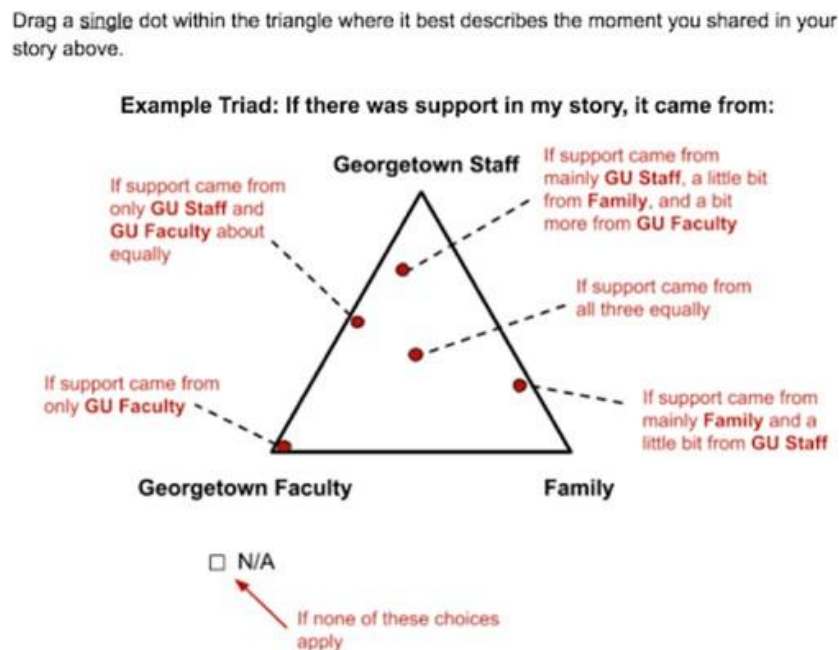
Self-report surveys have tended to be used mainly as research instruments, without returning any feedback to assist respondents. The sub-field of Dispositional Learning Analytics (DLA) has extended the survey paradigm with approaches that generate instant, personalised feedback. For instance, the multidimensional construct of Learning Power provides an assessment of lifelong learning competencies, is assessed via a validated Likert-scale survey, and visualised as a radar chart accompanied by a personalised feedback report (Buckingham Shum & Deakin Crick, 2012; Deakin Crick et al., 2015). One of the eight dimensions is belonging, assessed via questions that target academic belonging specifically. Subsequent research demonstrates that DLA add

explanatory power to models predicting learning outcomes (Tempelaar et al., 2021). We suggest that DLA could be one approach for students to self-report their belonging at significant junctures, and obtain instant personalised feedback and supportive advice appropriate to their current sense of belonging. In addition, the automated feedback could be used to scaffold coaching conversations with peers or instructors when needed, to close the feedback loop further.

Participatory narrative coding

An approach to the participatory analysis of complex human systems has been in development for over a decade by Snowden and colleagues (van der Merwe et al., 2019), grounded in the stories that stakeholders share. Snowden's work introduces quantification to traditional qualitative research, through what we call participatory narrative coding, whereby stakeholders use a web platform¹ to index their own stories against a range of dimensions (co-designed with stakeholders by the analytics/facilitation team). Its application to the study of student belonging is exemplified by Morrison, Young and Elmendorf (2020), in their analysis of minoritised student groups' experiences of belonging/alienation at an elite university. Figure 1 (top), from a belonging study at Georgetown University (Morrison et al., 2020), shows how an individual might code their story against a "triad" of dimensions visualised as a triangle, by dragging a dot to the most appropriate location in the triangle. From these data points, a cohort visualisation from all participants can be generated.

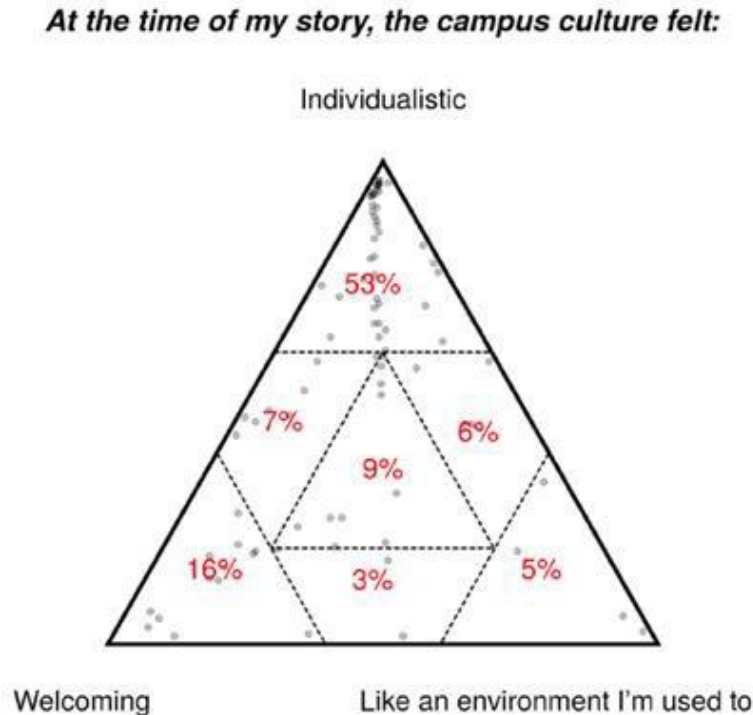
Figure 1a: Coding by students of their stories of belonging. Students drag the dot to the location in the triangle that best reflects their story.



¹ SenseMaker® <https://thecynefin.co/sensemaker/>

BELONGING ANALYTICS

Figure 1b: Aggregated codes provide a visual analytic (Morrison et al., 2020). (Note. The two example triangles illustrate different questions.) Figures used with permission.



This approach highlights several hallmarks that resonate with values in belonging research and practice: story (belonging is about lived experience, and knowing that someone has heard); student agency (users determine how to code their own stories); stakeholder dialogue (intentionally simple visualisations); as well as relationships (belonging is inherently relational). Such visualisations of data from students' stories, taken at regular intervals, augment student voice, and can provide snapshots of belonging for timely interventions.

Learning analytics dashboards

In the history of learning analytics, learning analytics dashboards (LADs) were one of the earliest tools. These systems aggregate students' digital learning traces, transform them automatically by algorithms, and present this to stakeholders (Schwendimann et al., 2017). Learning trace data serve as indicators of behavioural engagement. Given the affective nature of belonging, behavioural indicators alone are insufficient for gaining deeper insights into this aspect of students' subjective experience, or for understanding the diversity of student backgrounds and experiences (Williamson & Kizilcec, 2022). Notably, affective engagement – i.e., interest and enthusiasm (Kahu & Nelson, 2018) – is likely to be linked to behavioural engagement, and influence belonging. For example, studying with peers may foster greater enthusiasm in students, and increased academic belonging (Fjelkner-Pihl, 2022). Similarly, online behaviours could be tracked and supported in ways that build student belonging and success (Boroowa & Herodotou, 2022).

We now consider LA approaches that go beyond the aggregation and visualisation of behavioural traces.

Social network analysis

Social network analysis (SNA) is a methodological approach involving the study of ties between individuals in a community. While SNA research in the social sciences has typically relied on qualitative data from self-reported relations, LA adds a computational element by leveraging data from digital interactions for analysis, then quantifying and visualising patterns of these relations through metrics (Poquet & Joksimović, 2022). These metrics – betweenness centrality, closeness, degrees – can yield important insights into social processes in digital learning communities (Chen & Poquet, 2022).

As previously mentioned, belonging is inherently relational. Hence, understanding relationships and patterns of interactions is particularly important for gaining insight into students' experience of belonging. While SNA is a key methodology within LA (Poquet & Joksimović, 2022), only a few studies report using SNA to uncover important insights specific to belonging. Dawson (2008) applied SNA to forum logs from teaching units to examine patterns of interactions and relationships. Importantly, the analysis found that students with high betweenness scores (having diverse social networks) bridged connections between disparate, closed friendship groups. This early work highlights the significance of understanding “the position an individual occupies in the social network” (Dawson, 2008, p. 236), and how such findings can inform about the dynamics of belonging in digital environments. SNA tools have been developed to monitor student interactions at scale. A well-known example is SNAPP, the Social Networks Adapting Pedagogical Practice (Dawson et al., 2010; Kitto et al., 2016), an instructor-facing tool designed to capture automatically and to visualise student interactions for feedback to students about their interactions. SNAPP was aligned to the recognition that attention to social metrics was important for fostering participation, belonging, and ultimately, academic success (Dawson et al., 2010). More recently, de Medeiros et al. (2022) presented AMADEUS-SIMM, another instructor-facing tool, aimed at fostering belonging by monitoring and supporting student interactions. Initial experiments showed an increase in group cohesion when the course instructor acted on the information provided by the tool. This finding demonstrates how SNA interventions can have a positive impact on belonging.

Presently, SNA tools have yet to be implemented widely and to show consistent evidence of positive impact specifically on belonging. However, these few examples illustrate the potential for the wider use of metrics from social interactions to inform students' belonging, to monitor and support student interactions and, therefore, to foster community, especially in digital environments where interactions can be difficult to observe.

Writing and discourse analytics

While ubiquitous, clickstream data vary with respect to their quality; specifically, large, fine-grained datasets are needed for more accurate insights into the complexities of learning, such as engagement. However, not all learning environments provide such fine-grained data in order to yield rich insights. Alternatively, textual data abound from various sources – students' essays, discussion forums, open-ended survey responses, and interviews. Posts from student discussion forums have been identified as a viable source of data to uncover students' emotions, through sentiment analysis (Wen, Yang, & Rosé, 2014). In addition, students' reflective writing has been found to offer insights into cognitive engagement, for example critical thinking (Kovanović et al., 2018) and depth of reflection (Barthakur et al., 2022). Research has also explored the automated detection of affect in student feedback survey data (e.g., Bringula et al., 2022), which addresses the affective nature of belonging. Given the pace of advancement in text-mining approaches, and

the availability of text data, it is timely to explore textual data for insights into students' belonging. Reflective writing, in particular, when designed well, gives students an opportunity to tell their stories of developing thought and identities, offering a window into their affective and cognitive engagement (Buckingham Shum et al., 2017). For example, students may be prompted at the end of each year of their study to reflect on their developing identities as professionals. Students' reflections in this context would present opportunities for gaining insights into belonging at the discipline level, and address the challenge of tracking this longitudinally as noted previously.

Activity-based personalised feedback

A key vision of learning analytics is to support students in gaining insights into their engagement, thereby closing the feedback loop (Clow, 2012). In line with this mission, there now exist "systems that care" (du Boulay et al., 2010) that personalise feedback and support to address students' motivation, metacognition, and affect; for example, ECoach (Matz et al., 2021), OnTask (Pardo et al., 2018), and the Student Relationship Engagement System, SRES (Liu et al., 2017). Such systems have shown promising outcomes relating to student performance and self-regulated learning, with some suggested impact on students' sense of belonging (e.g., Arthars et al., 2019; Lim et al., 2022).

Currently, personalised support systems draw mainly on learning activity data. We propose that the identification of belonging analytics would enable educators to tailor timely feedback and support to students in order to foster their belonging. For example, the analytical agent (refer to Table 1) may sense an abrupt and sustained shift in patterns of learning management system (LMS) behaviour which could then trigger a response – either by the educator or machine – to reach out with personalised advice or support to the student. Much care, however, should be taken not to assume an issue with belonging, but to invite the student to "a conversation to clarify, confirm and offer support" (Prinsloo, 2019, p. 6). Additional survey data on students' self-reported belonging could then be used to triangulate the behavioural indicators automatically captured in digital systems and tools. Moreover, considering the limitations of behavioural indicators (see section "Learning analytics dashboards"), textual, narrative data may be captured periodically, and automated detection techniques employed to identify quickly students' current state of belonging. The results of all these analyses can then be used to guide personalised feedback and support.

Open questions to advance the field

To summarise, belonging is undoubtedly a priority in higher education, yet its complexity and dynamic nature present challenges in addressing this important aspect of the student experience. In this paper, we have outlined a range of Learning Analytics approaches within a framework of Belonging Analytics (Table 1). We have proposed new ways of monitoring and supporting student belonging over time and at scale, harnessing a variety of data sources. We recognise that much work is needed to ensure that data sources to inform belonging are firmly grounded in theories of belonging, and that analytical approaches are not biased or increasing inequity. From these ideas, we suggest the following questions that, while not exhaustive, would in our view progress this line of research and practice.

Definitional questions:

- To what extent are students' and staff perspectives of belonging aligned, and how do we bring students' and staff voices into dialogue for participatory design?

- If the recent critiques of “belonging” transition into more focus on “mattering” without a student having to assimilate into the university culture, what are the implications for LA?

Technical questions:

- In trying to quantify belonging, what value is provided by data at different levels of belonging: classroom, discipline, institution/campus?
- What are key ethical considerations when trying to track belonging with data?

Research and practice questions:

- How do students’ “belonging analytics trajectories” vary with demographics or disciplines?
- How does the impact on students’ belonging differ with the use of different belonging analytics approaches?

We hope this proposal to use Learning Analytics to build students’ sense of belonging excites the reader, and we welcome responses from the community on the arguments and examples we have presented.

Lift Learning

The authors recently presented on the topic of Belonging Analytics at Indiana University’s 5th International Learning Analytics Summit. Engage with part of this discussion through this article’s companion LIFT Learning site where the authors describe their proposition and lay out the key concepts and challenges associated with belonging. As part of this, the authors discuss the case study presented in the article in greater detail, and provide additional contextual information that enhances the reader’s understanding of the proposal. The LIFT Learning site is available at <https://apps.lift.c3l.ai/learning/course/course-v1:LEARNINGLETTERS+0104+2023>

Funding

The author(s) declared no financial support for the research, authorship, and/or publication of this article.

Disclosure statement

The author(s) declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

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